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THE STORY OF CREATION.

A PLAIN ACCOUNT OF EVOLUTION.

By Edward Clodd.

PART II.

Chapter IV.—THE ORIGIN OF SPECIES.

THE history of the slow but sure preparation of the scientific world for the reception of a theory displacing the old notions of the fixity of species is briefly but vividly told by Mr. Grant Allen in his monograph on "Charles Darwin."* Commending the study of that book, especially of the fifth chapter, as superseding the need for repeating the story here, we may pass at once to a rapid summary of the evidence as to the modes of organic evolution.

I. *No two individuals of the same species are exactly alike; each tends to vary.*—Of this obvious fact every species, from man downwards, supplies abundant illustration; for however closely individuals resemble one another in essential features, causing them to be grouped under the same species, there are always differences between them, often very marked, both in organ and function. Children of the same parents vary in size, feature, complexion, character, and constitution, often very obviously, sometimes too obscurely for detection; and this law of general resemblance, with more or less variation in detail, applies to all animals and plants. The tendency to vary, which, in our ignorance of its ultimate causes, we say "inheres" in the organism, and of which what are called "sports" are an example, is fostered by the change of condition in which the animal or plant may be placed, as shown in its more marked tendency to vary in a domesticated than in a wild state. Throughout these papers stress has been laid on the fact that the organ adapts itself to the work which it has to do; hence changes of structure in a species are necessitated to fit it for an altered state of things. This implies increased or lessened activity on the part of certain organs, the use or disuse leading to their development or suppression.

II. *Variations are transmitted, and therefore tend to become permanent.*—In other words, what is peculiar to the parent plant or animal reappears in the offspring. This is known as "descent with modification," the serious import of which will be shown later on.

III. *Man takes advantage of these transmitted unlikenesses to produce new varieties of Plants and Animals.*—He selects certain individuals possessing variations which he wants to preserve, and allows only them to breed together, by which means in the course of time he produces varieties differing greatly from the parent form with which he started. The stock example of this is the pigeon. All our domestic pigeons, exceeding in number a hundred well-marked races, are descended from the ordinary blue rock-pigeon of the European coasts. Variations as marked as the fan-tail, the tumbler, and the pouter, have been produced by the breeder selecting birds with certain peculiarities, and choosing from each successive brood only those which exhibited the same peculiarities in more marked form, the result being, after a long time, the production of entirely new varieties. The same method has given us different races of dogs, sheep, horses, and other domestic animals. The fleetest horses are chosen to breed together; then the fleetest offspring of these in succession, until horses are produced whose swiftness far exceeds that of the originally selected pairs. In the development of the cart-horse strength, not speed, is the quality selected: while in the marked unlikenesses between dogs we see the result of artificial selection in producing such varieties as the blood-hound, the terrier, and the spaniel. What varieties in flowers, vegetables, and fruits—as, for example, the development of the numerous kinds of apples from the small, sour, crab species—the like method has induced, are too well known to need detailed reference here. When we see how successfully this choice of slight variations has brought about plants and animals best adapted to the service of man, we may desire the approach of that future when artificial selection will be extended to the human species, so that only the men and women who are of the highest type, both physically and morally, shall reproduce their kind.

Now the important work which Darwin did was to show that what man does on a small scale within a limited range of time, Nature does on a large scale during countless epochs; with the further difference that the action of Nature is not purposive, as is the action of man, but involved in the necessities of things. We may quote what Darwin himself says on this matter:

> As man can produce, and certainly has produced, a great result by his methodical and unconscious means of selection, what may not natural selection effect? Man can act only on external and visible characters: Nature, if I may be allowed to personify the natural preservation or survival of the fittest, cares nothing for appearances, except in so far as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good: Nature only for that of the being which she tends. Every selected character is fully exercised by her, as is implied by the fact of their selection. Man keeps the natives of many climates in the same country; he seldom exercises each selected character in some peculiar and fitting manner; he feeds a long and a short-beaked pigeon on the same food; he does not exercise a long-backed or long-legged quadruped in any peculiar manner; he exposes sheep with long and short wool to the same climate. He does not allow the most vigorous males to struggle for the females. He does not rigidly destroy all inferior animals, but protects during each varying season, as far as lies in his power, all his productions. He often begins his selection by some half monstrous form; or at least by some modification prominent enough to catch the eye or to be plainly useful to him. Under Nature the slightest differences of structure or constitution may well turn the nicely-balanced scale in the struggle for life, and so be preserved. How fleeting are the wishes and efforts of man! how short his time! and, consequently, how poor will be his results, compared with those accumulated by Nature during whole geological periods? Can we wonder, then, that Nature's productions should be far "truer" in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship?*

IV. *More organisms are born than survive.*—To quote Darwin once more, "there is no exception to the rule that every organic being naturally increases at so high a rate that, if not destroyed, the earth would soon be covered by the progeny of a single pair. Even slow-breeding man has

* "English Worthies" Series. Longmans.

* "Origin of Species," sixth ed., p. 65.

doubled in twenty-five years, and at this rate in less than a thousand years there would literally not be standing room for his progeny."* If all the offspring of the elephant, the slowest breeder known, survived, there would be in 750 years nearly nineteen million elephants alive, descended from the first pair. If the eight or nine million eggs which the roe of a cod is said to contain developed into adult cod-fishes, the sea would quickly become a solid mass of them. So prolific is its progeny after progeny, that the common house-fly is computed to produce twenty-one millions in a season; while so enormous is the laying power of the aphis, or plant-louse, that the tenth brood of one parent, without adding the products of all the generations which precede the tenth, would contain more ponderable matter than all the population of China, estimating this at five hundred millions!

It is the same with plants. If an annual plant produced only two seeds yearly, and all the seedlings survived and reproduced in like number, one million plants would be produced in twenty years from the single ancestor. Should the increase be at the rate of fifty seeds yearly, the result, if unchecked, would be to cover the whole globe in nine years, leaving no room for other plants. The lower organisms multiply with astonishing rapidity, some minute fungi increasing a billionfold in a few hours, and the protococcus, or red snow, multiplying so fast as to tinge many acres of snow with its crimson in a night. But we need not give further examples of this fecundity whereby Nature, "so careless of the single life," secures the race against extinction.

V. *The result is obvious: a ceaseless struggle for food and place.*—In that struggle the race is to the swift and the battle to the strong; the weaker, be it in brain or body, going to the wall, the vast majority never reaching maturity, or if they do arrive at it, only to be starved or slain. As amongst men, competition is sharper between those of the same trade, so throughout the organic world the struggle is less severe between different species than between members of the same species, because these compete most fiercely for their common needs—plants for the same soil, carnivora for the same prey. But whether the battle is fought between allied or unallied species, the victory is never doubtful—it is assured to the plant or animal that has some advantage, however slight, which its opponent lacks. Among plants growing in a dry soil, those whose leaves have thicker hairs upon them will absorb more moisture from the air than plants with less hairy leaves, and competing successfully with these, will survive to transmit their advantageous variations. Again, such as are better able to resist the depredations of burglarious insects by protection of thorny or prickly stems, or by nauseous taste, will thrive and multiply, while plants lacking these defences dwindle and become extinct. So with those which by showy colours of their flowers and sweeter nectar attract insects whose visits are desired as carriers of pollen from stamens to pistils. These secure propagation, while plants less attractive remain barren. The birds that are strongest on the wing reach the land whither they migrate, while the weaker perish by the way. The lions of sharper sight and more supple spring, the wolves of keener scent, secure their prey, while the feebler members starve. It is with man as with the organisms below him: the quickest in intellect, and those with greater power of endurance, distance the weak or the stupid, who fall behind, and, finally, slip out of the ranks altogether.

But the subtlety and variety of the conditions upon which natural selection seizes escape the keenest observers. Of their success, however, in tracing the varying fortunes of species Darwin gives a striking illustration in his explanation of the absence of wild oxen and horses in Paraguay. This is due to the action of a small fly which lays its eggs in the navel of newly-born calves and foals, the maggots hatched from the eggs causing the death of the young animals. Now, supposing this parasitic fly to be destroyed by an insect-eating bird, oxen and horses would abound in a wild state, and as they would eat certain plants, the vegetation would be altered, and these changes in the flora and fauna would involve changes of increasing complexity.

The inter-relation between the proportion of old maids and an abundance of red clover is not, *primâ facie*, quite as obvious. But it may be proved in this wise. The clover is fertilised by humble-bees, the number of which is determined by the number of field-mice which destroy their nests. The number of field-mice, again, is determined by the number of cats, and the number of these finally by the number of old maids who keep them! Therefore, as red clover is excellent food for cattle, and cattle are excellent food for man, elderly spinsters are benefactors to their species!

The important part played by colour and mimicry in the struggle for life has been demonstrated by Darwin, Wallace, Bates, and other acute observers. The more closely that an animal approximates in form and hue to its surroundings, the easier does it escape detection by its pursuer, and the easier does it avoid the notice of the prey which it pursues. In conformity with this we find that most animals are protectively coloured, while those which are not are so constituted as to render such protection needless. As illustrative of the operation of natural selection in this matter, we may borrow an admirable example from Mr. Grant Allen.*

> In the desert, with its monotonous sandy colouring, a black insect or a white insect, still more a red insect or a blue insect, would be immediately detected and devoured by its natural enemies, the birds and the lizards. But any greyish or yellowish insects would be less likely to attract attention at first sight, and would be overlooked as long as there were any more conspicuous individuals of their own kind about for the birds and lizards to feed on. Hence, in a very short time the desert would be depopulated of all but the greyest and yellowest insects; and among these the birds would pick out those which differed most markedly in hue and shade from the sand around them. But those which happened to vary most in the direction of a sandy or spotty colour would be most likely to survive, and to become the parents of future generations. Thus, in the course of long ages, all the insects which inhabit deserts have become sand-coloured, because the least sandy were perpetually picked out for destruction by their ever-watchful foes, while the most sandy escaped, and multiplied and replenished the earth with their own likes.

Thus, then, is explained the tawny colour of the larger animals that inhabit the desert; the stripes upon the tiger which, parallel with the vertical stems of bamboo, conceal him as he stealthily nears his prey, the brilliant green of tropical birds, the leaf-like form and colours of certain butterflies, the dried twig-like form of many caterpillars, the bark-like appearance of tree-frogs, the harmony of the ptarmigan's summer plumage with the lichen-coloured stones on which it sits, the dusky colour of creatures that haunt the night, the bluish transparency of animals which live on the surface of the sea, the gravel-like colour of flat fish that live at the bottom, and the gorgeous tints of those that swim among the coral reefs.

Among the secondary causes of modification of species Darwin gives prominence to "sexual selection," or the struggle between males for the possession of females, the result being that the stronger males secure mates and transmit the qualities which have given them the mastery to their

* "Origin of Species," sixth ed., p. 51.

* "Charles Darwin," p. 97.

offspring. Every farmyard combat between cocks illustrates the truth of Schiller's lines:

> Meanwhile, until philosophy
> Sustains the structure of the world,
> Her workings will be carried on
> By hunger and by love.

And among the larger animals—as stags and deer, and notably fur-seals*—the deadliest combats take place at certain seasons for possession of the females. But there is competition less fierce in character, if not less fatal, to the weaker or unendowed, strength giving place to grace of form, brightness of colour, and witchery of song, the females making choice of the male that attracts them most, or, as among the highest species, where he has wealth or good social position. These condone infirmity and ugliness.

Sexual selection thus explains the development of special features which, transmitted in increasing degree through a series of generations, have contributed to the survival of the fittest. For whatever these features may be, whether weapons of defence or attack, plumage and song of birds, colours of butterflies, perfume as of the musk-deer, or acrid taste as of the toad, their presence is explained by their utility, since, as with the flowers and scents wherewith plants attract insects to secure fertilisation, the primary function of colour, form, ornament, and whatever else has given advantage to plant or animal over its competitors is its service to the organism, and not, as man in his conceit has assumed, the delight or profit which it has given to him.

COAL.

By W. MATTIEU WILLIAMS.

ASSUMING that the seam is reached by the methods already described, that the roads are made for carrying it to the shaft, we now require to learn how the collier cuts up the seam into the portable lumps with which we are all familiar. The usual mode is by what he calls "holeing," which, if I am not mistaken, is another mining technicality of Scandinavian origin, as it is not by any means making a hole, but is undermining in order to overthrow, and *holfa* and *hvolfa* are Icelandic verbs signifying to turn over or overthrow.

The mode of holeing is to undermine the seam by cutting a groove along the lower part of the coal or the bed of rock that underlies it. This is made as narrow as possible to save labour and coal, and extends horizontally under the seam to a distance of two or three feet, as far as the collier can freely reach with his pick, which is made narrow and sharp for the purpose. The position of the worker when holeing is apparently very awkward and constrained. He lies on his side or squats sideways, and swings the pick horizontally, delivering several smart blows before he scrapes out the fragments he has made. In thin seams his position appears most painful, but he endures it patiently, without grumbling more than other men grumble at their daily labour.

In colliery districts where the prevailing seams are less than five or six feet thick, this mode of working, and the constant habit of accommodating the body to a low roof, has developed an interesting muscular modification. If the reader should be passing through such a district, he may distinguish a collier in repose from any other member of the population. His favourite position is to squat on his heels, leaning his back against a wall, just as he rests underground during the merry dinner hour. On a bright Sunday afternoon he squats in this queer attitude against the wall by the side of his cottage door, supremely happy in the enjoyment of his short pipe and the rare luxury of bathing in the sunbeams.

Thus undermined, the coal either breaks down by its own weight, or is thrown down by driving wedges into it a few feet apart by means of heavy hammers, or boring holes (this is *not* called holeing) with a drill and blasting with gunpowder.

Blasting with gunpowder is of course inadmissible where there is any liability to accumulation of fire-damp, but as the cutters are paid by piece-work, the temptation to adopt it is very great, because much more can be thrown down with a given amount of labour by blasting than by wedging. Thus is sometimes presented the anomaly of miners carrying safety lamps and blasting with gunpowder in the same working. Mr. Galloway has shown by a long series of careful investigations that the danger of blasting is by no means limited to pits or workings containing explosive gases. A working may be quite free from these and yet an explosion, with fatal consequences, may follow an ordinary blasting shot. This happens when there is much dry coal-dust accumulated in the immediate neighbourhood of the shot and extending far beyond. Each of the millions of minute particles takes fire by combining with the oxygen of the air, and fires its neighbour, the combined result being an evolution of a great volume of carbonic oxide and carbonic acid gases, and gaseous water, as well as a destructive outburst of flame; the expansion of the gases driving the flame along the workings with a force and velocity comparable, though inferior to, the generation and propulsion of ignited gunpowder gases through a gun.

Many substitutes for gunpowder have been proposed. One of the most promising is that of using the expansive energy of the chemical union of water with quicklime. When the hydrate (slaked lime) is thus formed a considerable increase of bulk occurs. By filling a bore-hole with lime instead of gunpowder, then tamping or plugging and admitting water by permeation, the expansion of the solid lime exerts a disruptive force like that of the expansion of the gases evolved by the combustion of the gunpowder.

Some seams are cut at the middle or top and wedged accordingly. There may be various reasons for this. Thus, in working the Flintshire cannel, which consists of two beds—the smooth cannel and the curly cannel—it was customary when I was there to hole into the top, and wedge up from the bottom, because the upper smooth cannel has a much smaller value than the curly below it, and is much softer than the bituminous shale which is below the curly cannel. That part which is cut away in the work of holeing is, of course, reduced to slack, and is of little value—so little that I have seen it freely used for ballasting railway sidings, being cheaper on the spot than gravel or stony soil.

A great deal of this slack is now utilised by making it into "patent fuel," *i.e.* blocks formed by conglomerating the fine fragments by means of pitch or tar or other binding material, aided by pressure, or even by great pressure alone. Square bricks or cubes as large as may be conveniently handled are thus formed, the value of which is well appreciated by those who have travelled far in steam-packets, and know the grimy horrors of ordinary coaling, as compared with the cleanly shipment of these blocks. Their compact stowage is a further great advantage.

It is evident that if the whole of a seam of coal were thus cut away and removed at random over a wide area, the rock above would fall in and bury the miners. The simplest

* Cf. Elliott's "An Arctic Province," ch. x., for a vivid account of the battles between the males for priority on the breeding-grounds of the Pribylov Islands.

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and most obvious remedy for this is to cut away only a portion of the coal, leaving other portions standing to support the roof. This is the old and primitive method of working, which is still followed in many colliery districts. It is variously designated "pillar-and-stall," "post-and-stall," "bord-and-pillar," and in Scotland "stoop-and-room" working. There are various modifications of this mode of working, the technical details of which it would be tedious here to describe. The problem is by no means a simple one, the necessities of ventilation being imperative, as well as the economical and safe removal of the coal itself.

The simplest and commonest mode of pillar-and-stall working may be understood by comparing the proceedings to the laying-out of the ground-plan of a new American city, the coal which is first cut out corresponding, on a somewhat narrower scale, to the parallel main avenues and the side streets at right angles to them, the pillars of coal that are left behind corresponding to the houses between the streets. A current of air, amounting in some cases to a fresh breeze, is made, by means to be described hereafter, to traverse all these streets, though their united length may run into miles.

It is obvious that a large amount of coal remains as supporting pillars after all this street cutting is done. The pillars may amount to as much as three-fourths of the seam, and rarely if ever to less than one-third, modern progress tending rather to increase their dimensions as the pits are deeper. In some of the deep Newcastle pits they amount to as much as four-fifths: 30 to 40 yards long and 20 to 30 yards wide. As much as 40 yards by 40 yards are reached. These, of course, have to be finally removed more or less completely, and this removal or "robbing" of the pillars is a dangerous part of the miner's work. In pits where open candles are used in the primary workings, safety lamps are demanded for this. This demand, in such cases, is, I suspect, rather due to the coal dust than to the fire-damp, which is commonly credited with it.

The pillars are cut away one by one, and "juds" or wooden props are wedged into their places. This is continued until all the pillars of one compartment of the mine called a "panel" are removed. Then the juds are knocked away, the roof falls in, and the floor creeps up, forming a mass of ruins called a "goaf."

A panel is simply a space of some acres surrounded by thick walls of coal, to cut off free communication with the other parts of the mine. This prevents the mischief that has arisen from the accumulation of gas in the midst of the *débris* of the goaf of old workings. These panel walls are the last portions of the coal to be removed before the pit is finally abandoned.

The mode of robbing the pillars is either by driving a bord through them, and thus obtaining a good place for the supporting juds in the middle part of the original pillar, or by slicing them away from their faces. Much care and skill is required in the economical and effective placing of the supporting props, and of pack walls to protect the men from the falling roof.

A vast quantity of coal, the wasted pillars of older workings, remains hopelessly buried. In the older and cruder modes of working the pillars were left as small as possible, and finally they were crushed, the roof coming down and burying them. The greatest waste of this kind has occurred in the richest of all our coal seams, the 10-yard seam of South Staffordshire. The great height between the floor and the roof of this seam—25 to 36 feet—renders the use of juds or wooden pillars inapplicable for support, and also demands some peculiar modes of working generally, which are thus described by Mr. Warington W. Smyth: "Main workings or *sides of work* are opened in the form of a square or parallelogram, 50 yards in the side or more, and shut off by a rib of coal 7 or 8 yards thick, at the least, from all other workings, except at the entrance a narrow *bolt-hole*. Driving out in the lower coals, and gradually rising to the higher ones, the colliers open stalls of 5 to 8 or 10 yards wide, forward and across, so as to leave square pillars, generally 9 or 10 yards in the side, and whenever the unsoundness of the coal or roof appears to require it, sparing additional supports of coal in *men-of-war* 3 or 4 yards square."

Those who are so easily satisfied, as many are, concerning the prospective duration of our coal supply should ponder on the fact that this wonderful seam, on which was based our supremacy in iron making and most of the other industries dependent on coal, is now very nearly exhausted; only a small fraction remains, and that is but the portion which is the most difficult to work, and which consequently must become dearer and dearer as the difficulty increases.

It is quite true that we shall never exhaust our coal supplies, for the simple reason that there will always remain a great deal which cannot be worked; but we actually have exhausted, or have reached the verge of exhaustion of those fields which, by their exceptional richness, gave us our advantages over our neighbours, who have now much more coal than we have, though none so cheaply obtainable as that which we originally had, and which twenty years hence we shall have no longer. We shall still have plenty of coal then, but it will be quite as costly as the coal of France, Germany, Belgium, &c., and much more costly than that of America and China.

In my next I will describe *long-wall* working, which is more economical, and when properly conducted, safer than the methods above described.

GREAT CIRCLE SAILING.

By Richard A. Proctor.

MR. FROUDE in his "Oceana" touches from time to time on great circle sailing, or, in other words, on that method of directing their course at sea, by which the wiser seamen take the shortest course from port to port. He is not always strictly accurate in his remarks on this advantageous method of sailing, but he is always interesting; nor do the slight errors in matters of detail detract from the general accuracy of his statements. At the very outset of his ocean travelling, one day only from Plymouth, we find him observing that the *Australasia* was "outside the Bay of Biscay, far to the westward of our course as traced on a flat chart; but the captain tells us," he proceeds, "that we should see it to be right on a spherical one, and we entirely believed him." In reality the great circle course from Plymouth to Cape Verde passes but slightly to the west of the course traced on a Mercator's chart, which we assume to be what Mr. Froude means by a flat chart—at any rate, it is the only kind of flat chart used by seamen. Yet the principle is sound which underlies Mr. Froude's statement; and, slight though the advantage may be which a great circle course has over a rhumb course (the ruled line on a Mercator's chart), the difference of distance is worth saving. In the case of a sailing vessel, indeed, which against adverse winds may have to beat across the course which a steamship or a ship under fair winds would pursue, a very slight gain on the shortest course may result in a very considerable gain on the whole journey. Consider, for

instance, the following statement in Professor Hughes's excellent little work on the construction of maps, a statement for the accuracy of which I can answer, having independently tested the matter: "In the case of a voyage from the mouth of the English Channel to New York, supposing a due west or adverse wind to last during the entire voyage, and presuming a ship to advance at the rate of 150 miles a day, the length of time occupied by her following throughout the tack nearest to the rhumb course (or that which would be pursued in the ordinary practice of navigation) would be forty-nine days, while by pursuing the tack nearest to the great circle course, the time would be diminished to forty-three days eight hours—the distance passed over being in the former case 7,361 miles, and in the latter 6,488 miles, a difference of 873 miles in favour of the great circle course."

It may surprise the reader perhaps to learn that, in such a journey as Professor Hughes has here considered, the "practical" seaman of the old school, who refuses to be troubled by "great circle nonsense," and sticks to his rule of thumb rhumb rules, will on certain parts of his course be actually increasing his distance from his port, by sailing as close as he can to the rhumb track pencilled on his chart. For example, suppose him off the Lizard; his rhumb course for New York, a straight line on Mercator's chart, would lie west-south-west; his shortest or great circle course would lie about west by north. Suppose now that the wind is about west-south-west, and that the ship cannot sail nearer than six points to the wind, then the proper course to pursue is to make long tacks to the north-west, only three points from the true great circle course, and short tacks to the south, in which a certain amount of distance is lost. But the practical old sea-dog who sticks to his rhumb line will take equally long legs to the north-west and to the south, supposing each to be about six points from his true course, whereas on every southern tack he is nine points from his true course to New York and only seven points from his true course *home*. Such is the practical effect of too strong a hatred of new-fangled ideas.

Mr. Froude remarks of the seeming departure of the *Australasia* from the straight-line track on the chart that, had the passengers been required to give their independent opinions, they would have voted "that we were going wrong, and must change our direction, especially if they suspected that the captain and officers were interested in the matter. They were not asked for their opinions, and did not wish to give them. They were contented, being ignorant, to be guided by those whom they supposed to know," on which he makes the rather odd comment, "This is the universal rule, and when it is observed our sums work out clear without fractional remainders."

This trust in the superior knowledge of the officers who direct a ship along the shortest route is especially taxed when long journeys have to be taken in high latitudes. For instance, imagine the state of mind of a passenger who, having opened his Mercator's map, had traced out thereon the track from Cape Agulhas to Melbourne, and found, at the end of the first day out, that the captain was taking the ship to the south-east instead of nearly due east as the map seemed to indicate. If perchance the passenger were a flat-earth man, and had provided himself with one of those ingenious maps in which Mr. Hampden (following the deceased Newton of the flat-earth folk, "Parallax"), presents the earth in cart-wheel form with the north pole as its centre, and the south polar regions around its circumference, the case would be even worse. For, drawing a straight line from the Cape to Melbourne on such a chart, the unhappy paradoxist passenger would recognise as the shortest track to Melbourne a course running considerably north of east, and the perversity of the captain in running considerably south of east would seem still more disastrously mistaken.

It may be imagined how far the shortest or great circle course may be from any such track as a chart would show as such, that if one were starting from England to China on a great circle course one would go neither to the east nor to the west, but nearly due north. So if one were starting from Cape Town to New Zealand, one would go neither east nor west, but nearly due south.

As a matter of fact, the actual great circle course in such cases cannot be pursued. The assaults made in former times on the problem of the north-western passage probably involved some perception of the fact that an Arctic journey, if practicable, was the best way to reach India; though a north-eastern passage, such as Nordenskjöld has accomplished, would be better than a north-western one, if both were not so difficult and dangerous as to be utterly useless, at least as ways to the Pacific Ocean. But even such moderate approach to the Antarctic regions as many journeys in the Southern Ocean would involve, if made along the great circle course, is in reality so undesirable that it may be regarded as to all intents and purposes forbidden by nature. Consider, for example, the following cases of icebergs seen in latitudes not nearly so high as those into which the great circle course from Cape Town to Adelaide or to Melbourne would carry a ship. They are cited by Mr. Towson in a paper on the Icebergs of the Southern Ocean, published by the Board of Trade:

On September 10, 1866, the *Lightning*, when in latitude 55° 33′ south, longitude 140 west, came across an iceberg 420 feet high.

In February 1850 Captain Clark, of the same clipper, records an iceberg 500 feet high and *three miles long*, seen in latitude 55° 20′ south, longitude 122° 45′ west.

On December 1, 1859, Captain Smithers, of the *Edmond*, reported *an island* 580 feet high and from two and a half to three miles long, in latitude 50° 52′ south, longitude 43° 58′ west. This island has not been admitted into the Admiralty charts, like some I know of, which for a time did duty there, but were discountenanced later. And there can be very little doubt that Captain Smithers's supposed island was merely an iceberg of enormous size. Probably the Antarctic tract recorded by Captain Wilkes, of Trent notoriety, and subsequently sailed over by an English ship, was a still more enormous field of floating ice, many miles in length, and averaging nearly a mile in total thickness.

In January 1861, five icebergs, one 500 feet high, were met with in latitude 55° 46′ south, longitude 155° 56′ west.

In the same month, 26′ farther south, and 4° 4′ farther west, an iceberg 500 feet high and half a mile long was found.

In April 1864, the *Royal Standard* came into collision with an iceberg 600 feet in height.

In December 1856, four large icebergs, one of them 700 feet high and another 500 feet, were met with in latitude 50° 14′ south, longitude 42° 54′ east.

On Christmas Day 1861, pretty near Midsummer Day, too, in the southern hemisphere, the *Queen of Nations* fell in with an iceberg in latitude 53° 45′ south (corresponding to the latitude of Hull or Leeds in our northern hemisphere), 720 feet high. This was in longitude 170° west.

On March 23, 1855, the *Agneta* passed an iceberg in latitude 53° 14′ south, longitude 14° 41′ east, 960 feet in height.

On August 16, 1840, the Dutch ship *General Baron von Green* passed an iceberg 1,000 feet high, in latitude 37° 22′ south (corresponding to the latitude of Seville in the north), and longitude 14° 10′ east.

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Lastly, on May 15, 1859, the *Roseworth* found in latitude 53° 40′ south, longitude 123° 17′ west, an iceberg as large as Tristan d'Acunha.

When we remember that the iceberg seen by the *Agneta* must have been upwards of a mile and three-quarters thick, we see what amazing masses of ice come forth from the Antarctic regions, and how unsafe it would be for seamen to pursue too scrupulously the great circle course on long voyages in the Southern Seas, seeing that such voyages, if pursued, would carry them into regions where ice masses even more portentous than those described would be crowded in even greater profusion.

Yet, are there no seas where, so far at any rate as eastwardly voyages are concerned, the great circle course seems more inviting than in the southern portions of the great Indian Ocean? For there within the "roaring forties," and even far to the south of them, the mighty west winds blow which raise the greatest waves which are known in our world. "Between latitude 40° and the ice of the South Pole," says the latest account published of these western winds, "a steady draught of air from the west blows perennially all through the year and all round the globe. It may shift a point or two to north of west, or south, but west it always is; never sinking below what we call a stiff breeze, and rising often to a gale or half a gale; and constantly, therefore, there is a heavy sea, nearly a thousand miles broad, rolling around the earth from west to east. The waves were magnificent," proceeds Mr. Froude in "Oceana"; "I believe the highest ever fallen in with are in these latitudes. Vessels for Australia under sail alone accomplish often three hundred miles a day on the course on which we were going. If they are bound west they keep within the tropics, where these winds do not reach. To steam in their teeth would be impossible even for the most powerful ships afloat."

Indeed so moved was Mr. Froude by the impressive picture presented by this zone of fierce west winds, urging the waters of the sea ever eastwards over the broad span of one thousand miles swept by their strong breath, that he was led to propound what on a later page he calls his own wave-theory depending on this phenomenon. I venture to digress for a moment to touch on this theory of Mr. Froude's, which, as it proved inviting to him, might be attractive to others, though based in reality on a singular misapprehension of mechanical laws.

The reader is doubtless aware that, owing to a certain acceleration, or apparent acceleration, of the moon's motion, beyond what the law of gravitation seems capable of explaining, astronomers have been led to entertain the belief that our earth's rotation, the clock by which we measure astronomical time, may be running gradually slower and slower century after century. The case may be compared to that of an apparent acceleration in the speed of a racer, equine or human, timed by a watch not thoroughly trustworthy; if such a watch were running slow, the timer might very well believe that the racer had gained more in speed than he really had—though perhaps a part of the observed difference might really be due to an increased velocity. To account for that portion of the moon's increased speed which could not be accounted for by gravity, a very slight diminution of the earth's rotation would be required, corresponding to the loss of much less than a second of time by our terrestrial clock in one year. It has been supposed that the whole difference may be explained by the action of the tidal wave in a direction contrary to that of the earth's rotation spin. The French mathematician, Delaunay, showed, in fact, by a calculation of great profundity, that the tidal wave raised by forces exerted on the earth from without must produce some effect on the earth's rotation. Airy, who at first doubted this, subsequently admitted the validity of Delaunay's reasoning; and the influence of the tidal wave in retarding the earth's rotation may be regarded as proved.* But it has become very doubtful whether any retardation actually takes place, and it is now generally supposed that the retarding influence of the tidal wave may be counterbalanced by some other causes, as yet not definitely determined, by which the earth's rotation may be hastened. Thus the earth's globe may be shrinking in sufficient degree to have its rotation thereby hastened as much as it is being retarded through the constantly westwardly motion of the tidal wave. Or there may be other accelerative causes. And just here Mr. Froude steps in with his own wave-theory. It struck him, he said, after describing the waves carried so steadily eastward by the mighty winds in the South Indian Ocean, that "a series of enormous waves for ever moving in one direction over so large a part of the earth's surface, might in some degree counteract the force which is slowly stopping the rotation of our planet. . . . These great waves in the Southern Ocean for ever moving in the opposite direction to the tidal wave, may at least so far counteract it as to add a few million years to the period during which the earth will be habitable."

But, alas! the answer to this is akin to the answer which George Stephenson made to the paradoxist who wished to enforce his own theory of perpetual motion. "All right," said the great engineer, "but before you demonstrate your theory, oblige me by doing what must be very easy to you if you can secure perpetual motion; take yourself up by the waist-band and carry yourself round this room; then I will listen to you—with pleasure." The earth is the weight to be rotated, the west winds are the force by which she is to be moved, and the thousand-miles wide zone of the Southern Ocean is as the waist-band by which she is to be carried round. Unfortunately, though the sun's heat by which winds are raised is an external force, all the mechanical action of winds is earth-born; for every breath of wind moving northwards there must somewhere be as much moving with equal force southwards; for every breath of westerly wind an equal force of easterly wind must somewhere be exerted. No balance whatever, in one direction or in another, can remain outstanding; for the law of motion discovered by Newton is not that action and reaction are pretty nearly equal, but that they absolutely and exactly counterbalance each other. The action of the winds is by no means like that of the tidal wave, where the mechanical forces at work have been called into action by the sun and moon, bodies acting on the earth from without.

These western winds in the southern seas, however, though they do not effectively fan the rotating earth, make the great circle track most advantageous for the seaman travelling towards the east. From Cape Town to Melbourne along a great circle course, the distance amounts to $5{,}566\frac{5}{6}$ geographical miles, whereas the distance on a rhumb line is no less than 6,154 geographical miles, or 587 knots farther. Nearly the whole journey would be favoured by strong westerly winds. An ordinary sailing

* Mr. Ellery, Government astronomer at Melbourne, expressed, I see, the opinion—in conversation with Mr. Froude—that the retarding influence of the tidal wave is not proved. But however skilful Mr. Ellery may have shown himself as head of an observatory, I have not heard of any studies he has pursued, or any investigations he has published, which would make his opinion of weight on a mathematical question of this kind, especially where two of the greatest masters of the mathematics of astronomy have been led, after a thorough examination of the evidence, to regard as demonstrated that which Mr. Ellery rejects as still unproved. In such cases, "unproved for me" would be the more accurate way of expressing doubt.

vessel would gain not a few days only, but weeks, by following the great circle track, supposing no icebergs intervened, and that no storms arose in high southern latitudes which, even though blowing in the right direction, would be too fierce for ordinary sailing, or might even dismast and disable the stoutest sea craft.

Even the most favourable great circle course, then, may have to be modified in order to secure safety, which must be the first consideration with all prudent ship-captains and with all wise shipowners. For instance, the great circle course from Cape Town to Melbourne would carry a ship into about 58° south latitude, as would also a great circle course round Tierra del Fuego to Cape Town. A course from Dunedin to Valparaiso would pass into still higher latitudes. These journeys would all be very dangerous, a large portion of each being infested by icebergs, and exposed also to storms so terrible that the stoutest clipper could not hope to pass through them with unclipped wings. It would ill-profit a captain to have shortened his journey a hundred miles or so, or even to have secured favourable winds throughout the whole of it, if half the journey had to be made under jury rigging, and a large sum had to be expended to restore the battered bulwarks, and replace the best sails torn from the bolt ropes by the hurricanes of the southern seas. The risk of actual loss through collision with an iceberg, or by foundering in some great storm, is great enough to be an important consideration to the bravest masters, and if not to all shipowners, to the wiser, and assuredly to all underwriters.

It is necessary, then, to follow a course designed to combine the greatest possible advantage in regard to distance and favourable winds with the least risk from icebergs and storm. This is done by following what is called the composite course. Supposing, for example, a captain or shipowner decides that on the journey from Cape Town to Melbourne no latitude higher than 50° south shall be touched, then the plan to be pursued is to travel on a great circle course from Cape Town to touch the limiting latitude parallel, and thence to travel along that parallel until the point is reached where a great circle course from Melbourne to that latitude parallel would touch it. This was the course pursued by the captain of the *Australasia*. Mr. Froude, after mistakenly remarking that the true great circle course from Cape Town to Adelaide would lie athwart the South Pole proceeds: "This way there is no passage; we were to keep within the 'roaring forties;'" and even so, though it was the southern midsummer, and the nights but two hours long, they had to prepare for the temperature of an English winter. "The thick clothes must come out of our boxes again," he says; "the fire will be relighted in the saloon; we may fall in with icebergs, and see snow upon our decks, and then in three weeks we shall be again in tropical sunshine amidst grapes and flowers."

Here, however, I must correct a rather curious mistake which appears in one or two treatises on navigation. It is asserted that the shortest way of passing from any one place to any other on the earth's surface, subject to the condition that the track shall nowhere pass above a given latitude, is not the composite course, but two great circle courses meeting on that point of the highest latitude parallel, which has the same longitude as the point of highest latitude on the actual great circle course. For instance, the most southerly point on the true great circle course from Cape Town to Melbourne lies in longitude 84° east and latitude 58° south; the composite course touches latitude 50° south about 72½° east, and leaves it about 98° east! Now, the idea which I describe as a "curious mistake" consists in supposing that a better course than the composite one would be to run great circle-wise from Cape Town to latitude 50° longitude 84° east, and thence also on a great circle to Melbourne. This journey, compounded of two great circle courses, would unquestionably be shorter than the composite course compounded of two great circle courses and one course along a parallel. But it would carry the ship *twice* outside the limiting latitude—viz., for a considerable distance on the west of the point where the two great circle courses meet, and for a still greater distance on the east of that point.

Recognising the advantages of great circle sailing—(1) in its simplest form where practicable; (2) in the composite course where a simple great circle course passes through inconveniently high latitudes; and (3) as judiciously combined with due consideration of winds and currents, the question naturally arises, Why do not all sea-captains seek to obtain to the fullest possible extent the advantages which this method of sailing offers? Shipowners ought to be even readier to adopt the principle of great circle sailing, since its employment would diminish not only the length of ocean journeys, but also sea risks and expenses.

It need hardly be said that captains who are navigators as well not only recognise the advantages of great circle sailing, but avail themselves also of those advantages. But it must be remembered that a large proportion of the masters of ships engaged in trade are unable to employ any but the simplest methods of navigation. Accustomed to rhumb sailing, they are not very willing to employ methods which require either complicated constructions or more or less recondite calculations. I use the word "recondite" rather than "difficult," because the former word corresponds with the real objection which many skippers entertain against processes of calculation. If a shipmaster knows that taking out certain numbers from tables, and dealing with them according to certain formulæ, he will get out his proper course at starting from any point to reach a given port, he yet has the feeling that in adopting the course so calculated he is, as it were, walking in the dark. A wrong figure or a wrong sign, or some misunderstood direction, might have made the calculation work out wrong, and the course on which, confiding in it, he sets out *may* therefore be very far from the best.

Thus, although Mr. Towson has provided a series of admirable tables for facilitating the practice of great circle sailing and composite sailing, it is found that a large proportion of the captains of ocean-going vessels care little to avail themselves of these tables. Steamers may follow a particular calculated track—though there are few steamers as compared with sailing ships or auxiliary steamships on the longer voyages to which the principles of great circle sailing chiefly apply. But sailing vessels are often driven far from the course which might be calculated, at starting, as the best; and once this has happened the calculations so made are practically useless.

On the other hand, Mercator's charts are so simple and a rhumb line is so easily drawn, being simply a straight line, that seamen are not greatly attracted to the use of methods requiring complicated constructions to obtain the required course, or showing that course in a way not easily interpreted. For we must remember what the sailor wants, and what, so far as the rhumb course is concerned, Mercator's charts actually supply. He wants not only to know through what latitudes and longitudes his voyage will carry him, but to know at each point of his journey the bearing of his course. Suppose, for instance, he has been driven off the track he had intended to follow, and finds himself in a certain position, he marks that position on his chart, and joins the point by a straight line with the place of his port as marked on the chart. This line shows him at once what course to

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pursue, for it crosses the meridians (or north and south lines) on his chart at precisely the angle at which the course he is to steer should be inclined to the north and south line through the ship. He can measure the angle on his map at once, without any construction for correcting it in any way; and then he can direct his course on the sea accordingly by the compass in the customary way, making only the usual correction for the deviation of the needle.

But now, suppose our skipper wishes to use some chart for great circle sailing. If he takes his usual sailing charts, he can only obtain the great circle course by a complicated construction, the actual curve which in a Mercator's chart represents a great circle course on the earth belonging to a class of curves whose properties can only be treated by the higher mathematics. Sir George Airy calculated a table, long ago, which was intended to facilitate the construction of approximate great circle courses on Mercator's charts; but to the use of this table the same objections apply as to the use of Towson's tables for calculating the whole course.

Is there, however, no form of chart by which the great circle course may be drawn, as in Mercator's charts the seaman draws the rhumb course, as a straight line? There is the Gnomonic Projection, by which this may be done; and if the seaman could turn to a gnomonic map containing his port of departure—or his position at any given moment—and his haven, all he would have to do in order to determine his proper track would be to draw a straight line from one point to the other.

But there are two very serious objections to the use of gnomonic charts. In the first place no gnomonic chart can conveniently show more than a small portion of the surface of the globe—for the scale increases enormously as the distance from the centre of the map increases. How enormous the scale becomes, far beyond the limits to which many projections can be carried, will be inferred from this, that to show a hemisphere on this projection a sheet of infinite size would be required. (Charts of infinite size are not approved of on board ship; they would be inconvenient even on the *Great Eastern*.) But apart from this objection, which is in reality fatal against the projection, there is another, which would suffice to make the course drawn on a gnomonic chart unmeaning and therefore useless to the seaman. All the angles at which the course is marked so simply on a gnomonic map are different from the real corresponding angles on the globe itself. For the shapes of all the spaces on a gnomonic chart are distorted, in varying degree, according to their distance from the centre of the chart. Since the essential object of a seaman's chart is to show him his bearings, this objection is altogether decisive, and accordingly gnomonic maps have not come into use for nautical purposes.

There is, however, another projection which, so far as I have learned, has never yet been used by seamen, which possesses advantages as great in relation to modern nautical requirements as Mercator's projection presented for the comparatively rough requirements of Mercator's time—or even for much later times when, according to Commander Maury, a seaman shaped his course from England to Boston so roughly as to be well content if he fetched up at New York instead. According to the plan which I thus propose for a nautical chart, which may either be used alone or in conjunction with a Mercator's chart, a chart can conveniently show the whole globe except either the Arctic or the Antarctic regions, according as the south pole or the north pole is made the centre of the map. The great circle course from any one point to any other point appears as the arc of a circle, the only feature in which the projection is less simple with reference to great circle sailing than Mercator's is for rhumb courses. (Though indeed a geometrician might be disposed to say that in this respect the proposed charts have the advantage, since in a geometrical sense it is much easier to describe a circle correctly than a straight line.) However, this is saying little until it is shown further how this circular arc is to be drawn. For instance, quite a complicated construction might be necessary to determine the centre and the size of the circle required. Here, then, is the construction, so simple that a schoolboy often could deal with it correctly. Describe a circle through the ship's place, the desired haven, and the antipodes of either point on the chart; this may be done without the trouble of any construction, simply by feeling about with a pair of compasses till the right centre and opening are found. But if construction be preferred, then the simple method given in Euclid, Book IV., for circumscribing a given triangle may be employed. This, however, is really useless, seeing that in twenty seconds the trial method will give all that is wanted, whereas construction may require perhaps a couple of minutes for an unpractised hand, or a minute or half a minute for one which is skilful in such work.

But the chief advantage of this new nautical chart has still to be mentioned. In regard to bearings, it has precisely the same qualities as Mercator's chart. All bearings are correctly presented; or, in other words, the circular arc, pencilled from point to point, cuts all the meridians at exactly the right angle, that at which the seaman's course must intersect the north and south lines on the globe when he is pursuing the shortest or great circle course.

It may be asked, however, how the new chart will lend itself to composite sailing, which, as we have seen, is often a necessity. It does so perfectly. The problem is to describe a circular arc which shall pass through the seaman's place, port, or haven, and shall touch a given parallel of latitude. All parallels of latitude are concentric circles on the chart. Suppose the parallel to be touched is that of 50° south latitude; then all that is necessary is to describe a circle on the chart, which shall pass through the seaman's place or haven, and touch *on the inside* the circle representing 50° south latitude, while it touches *on the outside* the circle representing 50° north latitude. Nothing can be easier, because the last two conditions manifestly determine the size of the required circle. For any one who will draw two concentric circles on a plane will find that to touch the outer one on the inside, and the inner one on the outside, a circle must have a radius midway in length between the radii of the two circles. The centre of the required circular arc lies on a given latitude parallel in the chart; and it need hardly be said that to describe an arc of given radius through a given point, and having its centre on a given arc, is child's play.

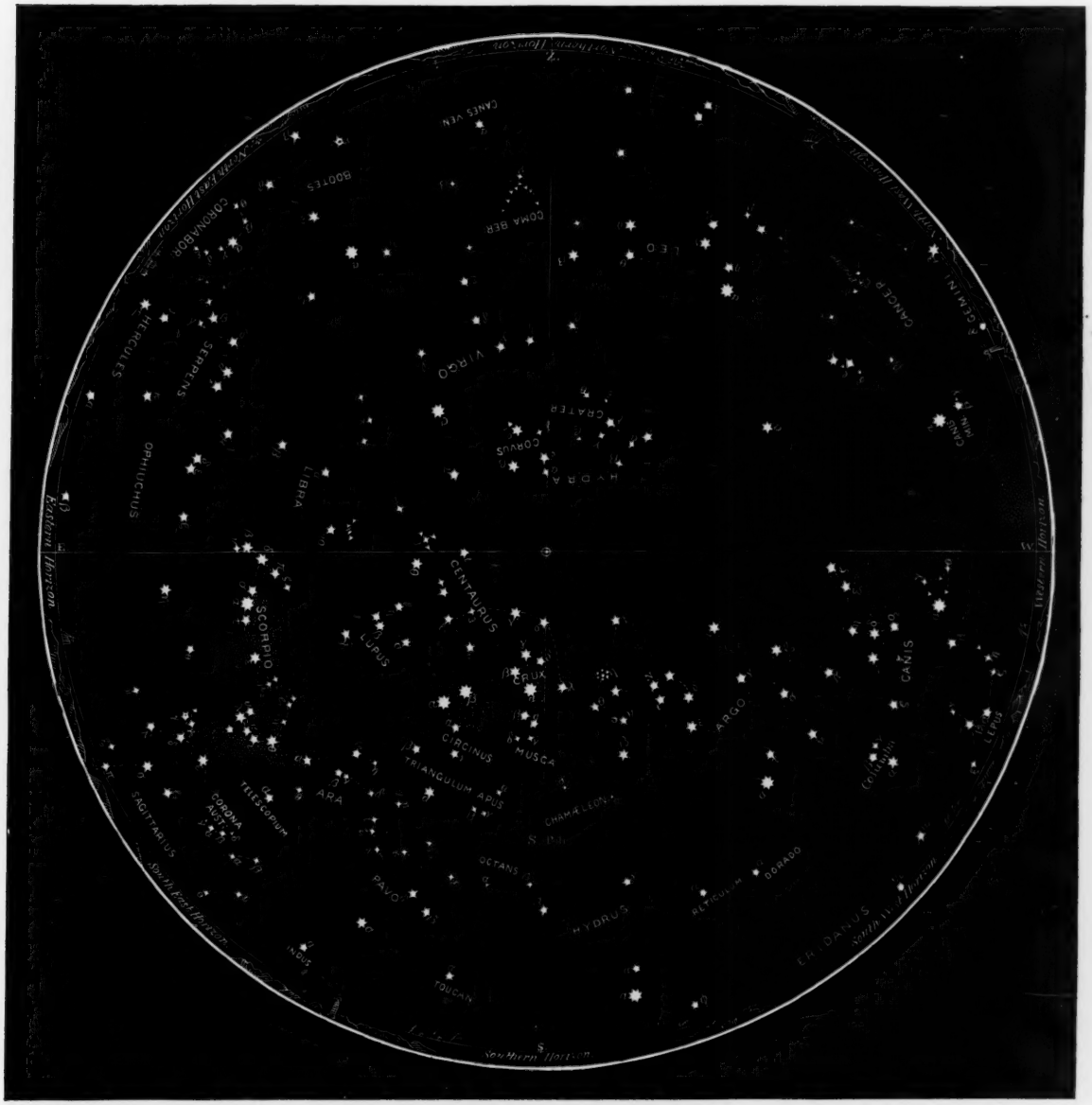
The drawing of the great circle course, or the composite course, as may be required, is the work of a minute or two at the outside. The interpretation of every point of the course thus determined is precisely the same as in a Mercator's chart. If the seaman has been beaten off his track, he can describe the shortest course from his new position as readily as he could describe the rhumb course on a Mercator's chart and interpret it as simply.

I venture then to express with confidence my belief that the new great circle sailing charts may serve the same purpose for seamen that Mercator's chart served in former times—saving much time, considerable expense, and many lives. For further information I may say with Mrs. Grudden, "see small handbills"—that is to say, consider the pamphlet accompanying the charts as issued by Mr. Stanford.

THE SOUTHERN SKIES FOR APRIL.

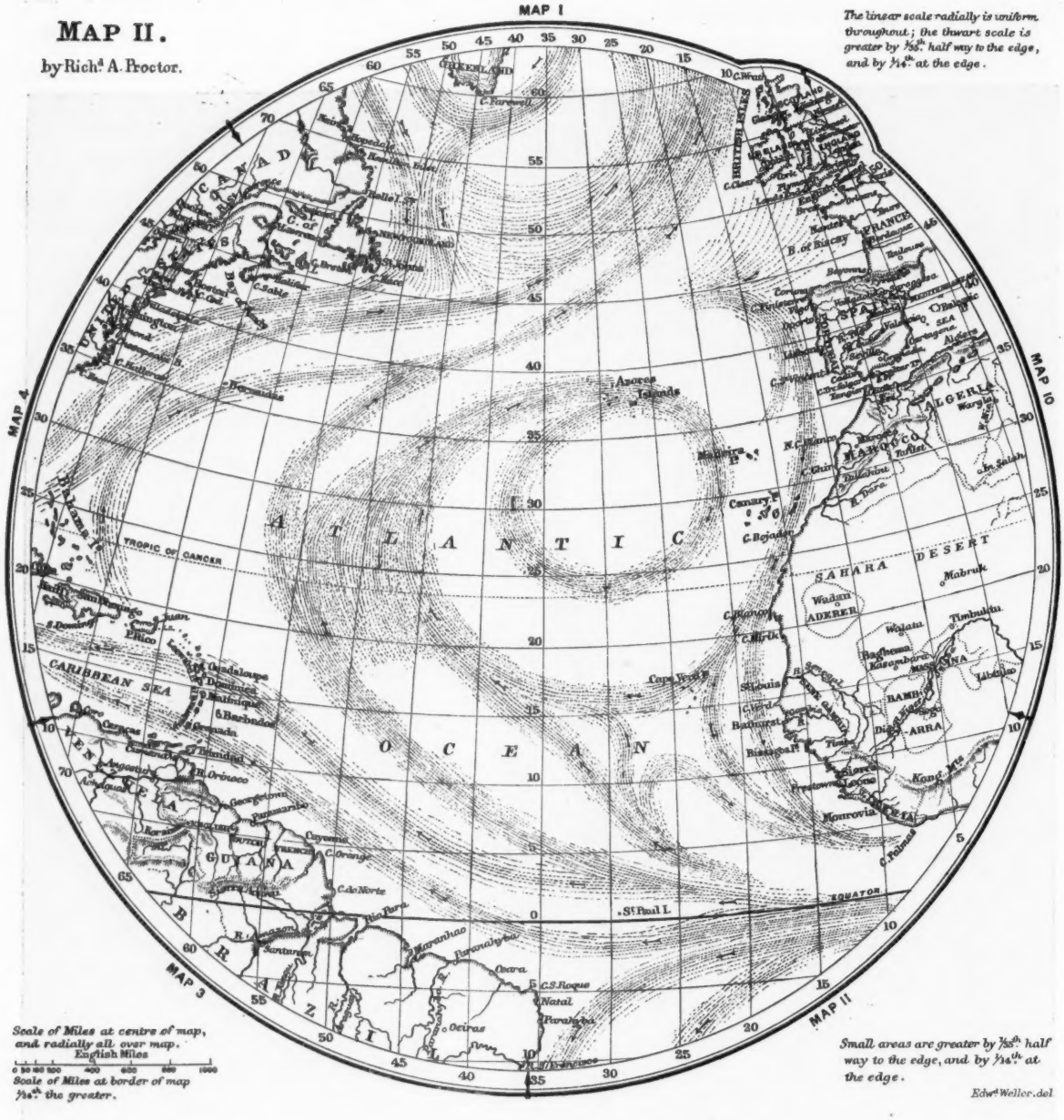
THE map showing the southern skies this month is to be interpreted as the maps which appeared in the December and January numbers were interpreted. As I have not yet received any proofs of the set of maps, completed to the end of the year, and write away from home, I am unable to consider the details separately. But as, in point of fact, the maps speak for themselves, this is a matter of small importance.

MAP V.—For February, March, and April.



The Night Skies in the Southern Hemisphere (Lat. 46° to 21° S.)
and the
Southern Half of our Northern Skies (Upper Half of the Map) at the following Times:

At 1 o'clock, morning, March 8.	At 11 o'clock, April 7.	At 9 o'clock, May 7.
„ 12.30 „ „ March 16.	„ 10.30 „ April 15.	„ 8.30 „ May 15.
„ Midnight, March 23.	„ 10 „ April 22.	„ 8 „ May 22.
„ 11.30 o'clock, night, March 30.	„ 9.30 „ April 29.	„ 7.30 „ May 29.


MAP II.
by Rich.d A. Proctor.
MAP I
The linear scale radially is uniform throughout; the thwart scale is greater by 1/58th half way to the edge, and by 1/14th at the edge.
MAP 4
MAP 10
MAP 3
MAP 11
ATLANTIC OCEAN
CANADA
FRANCE
SPAIN
ALGERIA
MOROCCO
SAHARA DESERT
CARIBBEAN SEA
TROPIC OF CANCER
EQUATOR
Azores Islands
Canary I.
Cape Verde I.
St Paul I.
Fernando Noronha
Scale of Miles at centre of map, and radially all over map.
English Miles
Scale of Miles at border of map 1/58th the greater.
Small areas are greater by 1/58th half way to the edge, and by 1/14th at the edge.
Edw.d Weller. del

THE ONE-SCALE ATLAS.

We give another map of this series, reserving an account of the method in which the sphere has been divided, and each map projected, till our space is less crowded.

PLEASANT HOURS WITH THE MICROSCOPE.

By HENRY J. SLACK, F.G.S., F.R.M.S.

A NEW spectacles are more beautiful and few more wonderful than to see the formation of crystals either on the stage of the microscope or with suitable materials on a magic-lantern slide. In a former article the exhibition of a silver tree in its rapid process of development was especially recommended. In this case a drop of solution of silver nitrate is placed on a slide, with the stage of the instrument horizontal. This plan—except when Stephenson's binocular is employed—is a little awkward with a tall microscope, as the tube is upright, but no other arrangement answers so well. A very small bit of copper, cut from the top of a wire, is put into the solution drop, after the latter has been focussed with an inch power. The chemical action is very rapid if the particle of copper is quite clear. Instantly a tree-like form springs forth, and the branchlets extend in all directions as if a living force impelled their growth. Each twig of the silver tree is seen to be made up of small crystalline particles, but the still minuter particles composing them are not discerned. The little silver crystals that unite to imitate the pattern of a plant are too thick to be translucent, as silver leaf is, and should be viewed under strong reflected light.

If we take another substance—say, tartaric acid, which crystallises very quickly from its concentrated solution—we see much the same process as with the silver solution, but the pattern is quite changed. Silver crystallises in octohedrons, and the native crystals often aggregate into thread-like and arborescent patterns, as in the microscope experiment. Tartaric acid crystallises in complicated patterns, which appear to be modifications of a rhombic prism. The tendency to complication makes it especially beautiful for microscopic exhibition, and its development should be watched under polarised light, which gives splendid colours. Even if the process is watched under a high power, the eye gains no vision of minute particles coalescing to make up any portion of the pattern. Each pattern visibly grows, and very fast, if the experiment is performed in a warm room and evaporation is rapid, but exactly how it grows is not made clear.

If, therefore, we want to see a little more of the way in which non-crystalline particles adhere to form crystals, we must select some substance that can be made to work in a manner and at a pace adapted to satisfy our curiosity. This was accomplished a few years ago by a German philosopher named Vögelsang. He thinned a little Canada balsam with bisulphide of carbon, which readily dissolves it, and in another small vessel dissolved a little bit of sulphur in the same fluid. Two half-dram tube bottles answer very well for the experiment. Two or three drops of the balsam in the state in which it is usually supplied, and about as much carbon bisulphide, will probably answer, but the amount of thinning the balsam requires must be learnt by a little practice; and it should be remembered that in thinning Canada balsam with any of its best solvents, the transition from being too thick to becoming too thin is very sudden after a certain point of dilution has been reached. A bit of brimstone the size of a peppercorn crushed into powder dissolves quickly in three or four times its bulk of the bisulphide.

Having prepared the two solutions, take a small glass rod, or, what will answer, two lucifer-match sticks. Use one for the balsam and one for the sulphur solution, or if the glass rod is employed clean it each time with a little benzine and a rag, so as not to get any sulphur into the balsam bottle. Put a small drop of the balsam on to a glass slide with the microscope stage horizontal, that it may rest quite still. Then, having focussed it with an inch or half-inch power, add to the balsam drop one of the sulphur solution. Bisulphide of carbon evaporates very quickly, and the crystallisation process begins at once. Now, if the balsam is of the right stickiness, it retards this process sufficiently to enable its stages to be seen. First comes the formation of a swarm of what Vögelsang calls *globulites*: tiny spherules, such as are formed by precipitation of a colloid substance, like mastic, when its alcoholic solution is thrown into water. These globulites are not like solid particles of the sulphur; they are plastic bodies, and build up crystalline forms of exquisite beauty, which should be viewed in various ways—with transmitted, and reflected, and with polarised light. The sulphur precipitated in this way acts upon polarised light in proportion to its advance in crystalline development. The globulites that have not begun to make crystals do not show any colours, while the most complete crystals are in a brilliant blaze of prismatic hues.

These experiments of Vögelsang are scarcely known in this country except to the few students of micropetrology, although making sulphur crystals for the polariscope has not been uncommon. It is probable, as Vögelsang considered, that when the chemical molecules of any substance are precipitated from solution and form crystals, the first stage of the process is their aggregation into globulites, which in many cases require high powers of the microscope to discern, and in others escape vision, either from the rapidity of the process or from their optical properties.

In forming Max-Schulze's artificial diatoms by a method explained in a former paper, we obtain globulites of silica which have enough plasticity to unite in vesicles like very thin glass bulbs. The process consists in putting a spoonful of powdered fluor spar, and one of fine silicious sand or powdered glass, into a common 6 or 8-oz. wide-mouthed bottle, pouring sulphuric acid over it, and lightly stopping the mouth with a loose flock of cotton wool saturated with water. It is well to let the apparatus rest for four-and-twenty hours, and then delicately remove the vesicles from the cotton threads, and wash all the acid out of them. They are then fit for the microscope.

The writer many years ago obtained exceedingly fine silica films by passing silicic fluoride gas through glycerine four parts to water one part. Here the adhesion of the globulites is feeble, and the slightest touch broke the films. Lately another experiment was tried, with interesting results.

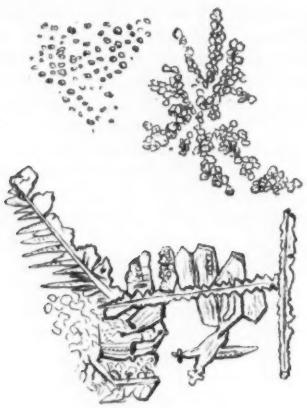
If the silicic fluoride gas is given off pretty quickly, which it will be if the bottle containing the preparation is kept warm in a water bath, the cotton is soon saturated with the fluosilicic acid and its fibre encased in silica. The cotton should be allowed to dry, and then small tufts lightly taken up with forceps and calcined in the flame of a spirit lamp in a platina capsule or spoon, or in a little Berlin crucible that will stand the heat. The capsule is the best, as the porcelain crucible will most likely be broken in inexperienced hands. For the water-bath mentioned above, take a round enamelled iron soap-dish, worth about sixpence.

If the cotton is well calcined, and moved carefully, the result is to obtain a sort of artificial fossil cast of the fibres, in the form of a number of hollow silica tubes, each built of innumerable globulites. They should be viewed with both transmitted and reflected light, and present very beautiful as well as curious appearances.

Instead of cotton fibre, pieces of wet sponge may be employed and calcined as before. A platina capsule about the diameter of a threepenny piece is big enough for these experiments, and can be obtained of the chemical apparatus

sellers for a small price. To hold it, make a wire clip about six inches long, and stick one end in the cork.

The figures below are copied from Vögelsang and represent the sulphur globules and crystals.



SOLUTIONS OF PUZZLES.

PUZZLE XIX. *To find the square sections of a tetrahedron; and to fill a square hole with a tetrahedral plug.*

First, let ABCD, fig. 1, be a tetrahedron; E, F, H, K, L, M, the bisections of its six equal edges. Then LFKH is a square; for LF and HK, being each parallel to BC, are parallel to each other, as are HL and KF. Also HL, LF, FK, and KH are all equal, each being half an edge of the tetrahedron. Therefore HF is a rhombus. But by symmetry the angle KFL=the angle FLH; and HL being parallel to KF, these angles are together

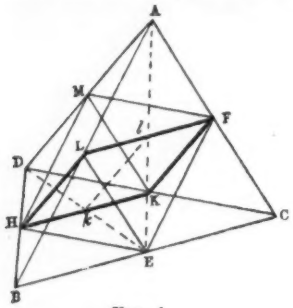


FIG. 1.

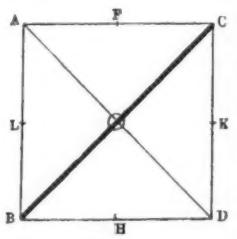


FIG. 2.

equal to two right angles; each therefore is a right angle. Therefore HLKF is a square. So also MFEH and ELMK are squares.

NOTE.—If the student does not feel the force of the argument from symmetry, he may for his own satisfaction prove LFKH a square, as follows: join AE, DE, cutting LF, HK in *l* and *k* respectively. Then BE being perpendicular both to AE and DE, is perpendicular to AED; so therefore are HK and LF perpendicular to AEF, for they are both parallel to BC. Also $Ll=Hk$, being the halves of equals. Hence LH is parallel to *lk*, and the angles *l*LH and *k*HL are right angles.

Secondly, to fill the square hole ABDC, fig. 2, with a tetrahedral plug. The figure shows the tetrahedron of fig. 1 fitted into the hole ABDC; ABC, BCD of fig. 2 being the faces so lettered in fig. 1, and ABD, DAC of fig. 2 being the other faces so lettered in fig. 1, supposed to be seen through the tetrahedron. The bi-sections of AB, BD, DC, CA are similarly lettered in both figures, while M and E of fig. 1 are brought into coincidence at O in fig. 2.

PUZZLE XX. *To find the regular hexagonal sections of a cube; and to fill a hexagonal hole with a cubical plug.*

First, let AG, fig. 3, be a cube; K, L, M, N the bi-sections of the edges AB, BC, AE, and EH. It is clear that if KL be produced each way, it will meet DA and DC produced in points P, Q, such that AP=AK=LC=CQ. So MN produced will pass through P, and meet DH produced in R, such that HR=HN=MA=AP. And obviously RQ will bisect HG, GC in S and T. Hence the plane of the equilateral triangle PQR gives the section required. For, joining MK, NS, LT, and noting that the points K, L, T, S, N, and M are the trisections of the sides

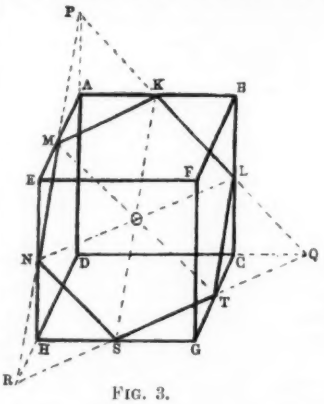


FIG. 3.

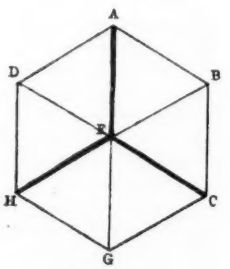


FIG. 4.

of an equilateral triangle, we see that LKMNST is a regular hexagon, from the well-known obvious properties of equilateral triangles.

And obviously there are four such hexagonal sections, which may be obtained by completing the square inscribed in ABCD, of which KL is a side and the construction as above.

Secondly, to fill the hexagonal hole ABCGHD with a cubical plug. The figure shows the cube of fig. 3 fitted into the hole ABCGHD; FA, FC, FH on the near side being the edges so lettered in fig. 3, and FB, FG, FD, supposed to be seen through the cube, are also the same as the edges similarly lettered in fig. 3.

PUZZLE XXI. *To find the regular hexagonal sections of an octahedron, and to fill a hexagonal hole with an octahedral plug.*

First, let ABCDEF, fig. 5, be an octahedron; G, H, the bisection of the opposite edges AD, BC; KL, NM respectively

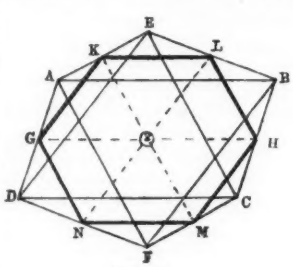


FIG. 5.

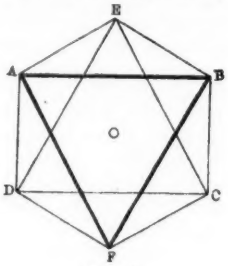


FIG. 6.

parallel to AB and DC, and bisecting the sides AE, EB, FD, FC. Then KL, GH, and NM are parallel and in the same plane

(since a plane through GH, if it pass through KL, must by symmetry pass through NM also). Join KG, LH, NG, and MH. Then the six sides of the figure, KLHMNG, are all equal, being each equal to half an edge of the octahedron. Moreover, GH, KM, and LN bisect each other in O, by symmetry; and OG, OK, OL, OH, OM, and ON are all equal, being each equal to half an edge of the octahedron. Hence G, K, L, H, M, N are on the circumference of a circle about O as centre, and therefore the equal-sided figure GKLHMN is a regular hexagon.

And obviously there are four such hexagonal sections, each section passing through the centre O of the octahedron, and being parallel to two opposite faces.

Secondly, to fill the hexagonal hole AEBCFD with an octahedral plug. The figure shows the octahedron of fig. 5, fitted into the hole AEBCFD; the letters corresponding in the two figures as in each of the two former cases.

OUR PUZZLES.

THE puzzles which suggest themselves for this month are the following:

Noting that space can be occupied by a series of equal cubes, which if originally arranged in layers, and each layer in rows, can be shifted in layers and rows:

PUZZLE XXII. *Show how to fill space with equal tetrahedrons and square-based pyramids, having their triangular faces equal to those of the tetrahedrons; and determine the movements which can take place among the solids so filling space, without leaving any spaces vacant.*

PUZZLE XXIII. *Show how to fill space with equal tetrahedrons and with equal octahedrons, having their triangular faces equal to those of the tetrahedrons; and determine movements as in Puzzle XXII.*

PUZZLE XXIV. *Find a solid, having all its faces equal (not, however, one of the regular solids, whose faces are all regular figures), such that space may be filled by equal solids of the kind, no displacements being possible without leaving vacant spaces.*

Those readers who do not care to attack these puzzles in the general form here presented, may take instead the following easier problems:

PUZZLE XXII. *Arrange four equal regular tetrahedrons, and six equal square-based pyramids having equilateral triangular faces equal to those of the tetrahedrons, in the form of a square-based pyramid.*

PUZZLE XXIII. *Arrange eight equal regular tetrahedrons, and six equal regular octahedrons with faces equal to those of the tetrahedrons, in the form of a regular octahedron.*

PUZZLE XXIV. *Draw on a card twelve equal and similar diamonds (rhombuses), determining their common shape and their positions on the card so that they may be cut out in one piece, and by suitable bending of diamond towards diamond, each diamond remaining flat, may form the* 12 *faces of a symmetrical solid, having* 24 *edges and* 14 *angles,* 6 *of the solid angles being each formed by the meeting of* 4 *of the smaller plane angles of the diamond faces, and* 8 *by the meeting of* 3 *of their larger plane angles.*

MINUTE MEASUREMENT.

(*Continued from page* 80.)

WE have said previously that when extreme delicacy of measurement in an astronomical instrument is essential the micrometer microscope takes the place of the vernier. Now the very essence of the accuracy of this instrument resides in the absolute truth of the screw which moves its index and cross wires, and, inasmuch as the screw also forms the essential part of every instrument now in use for the measurement of exceedingly minute quantities, it may be as well in beginning this branch of our subject to say a few words as to its principle, and the methods in which a perfectly true screw is produced. If we turn to any popular work in which the so-called "mechanical powers" are described, we shall find the screw defined as a continuous circular wedge or inclined plane, whose outline may be formed by cutting out a wedge-shaped piece of paper and wrapping it round a cylinder. Then will the edge of the paper represent the outline of the screw thread, which obviously preserves a constant angle to the axis of the cylinder; the angle of the wedge, with a cylinder of unvarying diameter, evidently determining the coarseness or fineness of the screw. We may take it, for our present purpose, that a screw must have been originated by very carefully wrapping such a wedge-shaped piece of paper as we have described round a cylinder, and then, with equal care, filing a groove upon it, upon the line traced out by the edge of the paper. The screw being thus made as accurate as possible, would be converted into a "tap"—or cutter—by filing grooves round it parallel to its axis, and with this tap an inside or "female" screw would be cut, which inside screw, or "die" as it is technically called, would in turn become a cutter whence copies of the original screw might be produced in any number. As we are not writing an article on practical mechanics, we need not point out how, by a repetition of these processes, a correction being introduced at each stage, the resulting screws come nearer and nearer to perfection, nor describe the elaborate art by which perfectly true screws are now cut with 100 threads to the inch. We will take their existence for granted, and proceed to describe how they are rendered available for the most minute and delicate measurements. Perhaps as suitable and typical an application of the screw as we can select for this purpose may be found in the micrometer microscope, by the aid of which angular deviations are read off on the limbs of astronomical circles to the tenth and even hundredth of a second of arc. Let us take one of those used to read the division on the limb of a mural circle, or large Altazimuth instrument, the primary divisions on the circle representing intervals of 5′. Now the microscope itself is a compound one, with an object glass, and that form of eye-piece known as the Ramsden or "positive" one, consisting of two plano-convex lenses with their convexities turned towards each other. Then, as in every other microscope, an image formed by the object glass in its focus will be magnified by the eye-piece, when the focus of the latter is made to coincide with that of the objective by sliding the eye-tube in and out. It will further be evident that any material object placed accurately at this focal point will be seen superposed on the optical image formed by the object-glass. Now, in the instrument which we are considering, at such focus is placed the spider-line micrometer which is shown in fig 5. Here we see a rectangular frame, moved by the screw *s c*, whose milled head, M H, is divided into 60 equal parts. The circle represents the field of view of the microscope, and the

XUM

short dark vertical lines *d d* are the 5′ divisions on the limb of the instrument itself. The comb C does not move with the spider-lines to be immediately referred to. The object-glass of the microscope is screwed up or down until five revolutions of the milled head carry the crossed spider-lines S L exactly from one division to the next. It must be, of course, thoroughly understood that the microscope itself is a fixture, and that the telescope and circle moving together carry the divisions on the latter across the field of the microscope; and if we suppose the middle notch of the comb C and the intersection of the spider-threads to be in a line, and the zero of the circle on the milled head to be opposite to its index (not shown in the figure), then will this intersection of the crossed spider-lines become a fixed point of reference, and the divisions which pass it as the telescope and circle rotate together will show the angle through which the telescope has moved. Let us now suppose, though, that instead of such rotation bringing

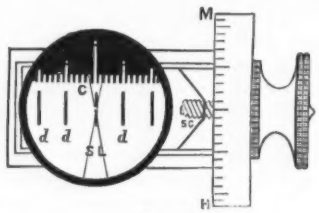


Fig. 5.

the cross accurately on to a division, it falls between two of them. In this case we turn the milled head until the intersection of the lines coincides with the graduation *beyond* which the motion of the telescope and circle has carried it, and read off the revolutions and parts of a revolution made by the milled head. Let us take an example. We have said that each graduation on the limb of the instrument represents 5′; and that exactly five revolutions of the milled head carry the cross-wires from one of such graduations to the next. Moreover it will be remembered that the milled head itself is divided into 60 parts. Now let us imagine that the graduation reads 274° 15′, and a certain quantity equal in terms of the micrometer to three whole revolutions (measured on the comb C) and 41·7 divisions of the milled head. This quantity, by which the cross-wires have to be moved back to coincide with the 15′ division obviously is equal to 3′ and $\frac{41 \cdot 7}{60}$th of a minute, or 41″·7. Adding this, then, to the whole reading we say 274° 15′ + 3′ 41″·7 = 274° 18′ 41″·7. If the reader has thoroughly grasped the principle of this instrument—and we would urge him to read and re-read our description until he does—he will see how, by making the thread of the screw very fine and the micrometer head very large, and, moreover, graduating the latter sufficiently minutely, there is scarcely any limit to our power of subdividing space. Suppose, for example, that the frame in fig. 5 were moved by a screw *s c* with 100 threads to the inch, and that the head M H (instead of having 60 divisions) were divided into 100 parts. Then, quite obviously, the turning of the screw through one of these parts would move the frame 100th of 100th—in short, $\frac{1}{10000}$th of an inch. An instructive illustration of the use of such a micrometer is found in the operations conducted between 1843 and 1854 for the construction of a standard yard-measure to replace that destroyed in the fire which consumed the Houses of Parliament in 1834. It is to the indefatigable labours of the late Messrs. Baily and Sheepshanks that we are mainly indebted for the possession of our present national standard, though as Mr. Baily unfortunately died a year after the commencement of the work, the overwhelming proportion of it devolved on Mr. Sheepshanks. The standard which had been destroyed was made by Bird, the optician, in 1760, from one, also of his construction, made in 1758; the last in turn having the Exchequer yard of Queen Elizabeth, constructed in 1588, and the yard of the Royal Society, dating from 1742, as its prototype. We have spoken just now of "the standard which had been destroyed"; but, as a matter of fact, both of Bird's yards—that of 1758 as well as that of 1760—were destroyed or irretrievably damaged in the fire in 1834. But other means of reference happily survived. *Imprimis*, there was General Roy's 42-inch measure, constructed by Bird, and first used for the measurement of that base on Hounslow Heath which was the very beginning and foundation of the Ordnance Survey. The first 36 inches of this were alone employed in subsequent comparisons, or rather two copies of that part of it. Then there was the yard constructed by Troughton under the direction of Sir George Shuckburgh, and a yard made by Capt. Kater in 1831. Formerly comparisons would have been made by means of beam-compasses, which, as most people are aware, consist of a rigid and absolutely straight bar of hard wood or metal, to one extremity of which is fixed a fine point at right angles to its length; while along the bar slides a box carrying a similar point, which can be moved by a screw, a vernier attached to the box showing the precise distance that the fixed and movable points are apart. But this, after all, was only a rough and ready method of taking off distances, and one open to the most serious objection that the mere insertion of the points of the compasses into the lines or holes defining the ends of the measure sufficed seriously to impair the graduation, to make the lines when magnified into ruts, and the points into irregularly-shaped pits, and so to gravely impair the value of the original as a standard. Instead, then, of the material beam compass, with its mischief-working points, the Commissioner employed what we may call an optical one in the shape of a bar furnished with two micrometer microscopes rigidly fixed 36 inches apart, beneath which the original bar was carefully supported, and bisections of the dots on it made by a contrivance analogous to that described above. By the subsequent substitution of the bar which had been copied from this original, the necessarily minute marks were brought under the microscope, and thus a series of comparison measures instituted. More than two hundred thousand (!) micrometer readings were taken from first to last, the larger part of them by Mr. Sheepshanks in the cellars of the old rooms of the Royal Astronomical Society in Somerset House, where the comparing micrometrical apparatus was fixed by Messrs. Troughton and Simms. We may add that one division of the micrometer head of this particular apparatus represented a movement of $\frac{1}{200000}$th of an inch. A similar application of what we have designated an optical beam compass is employed, in geodesical operations, in the measurement of the fundamental base lines. Such bases are, of course, measured rigidly in straight lines by rods most ingeniously devised to preserve an invariable length—a device which it may be worth while to digress for a short time to describe. There is a fact familiar to every one which is vulgarly and forcibly (if not quite philosophically) expressed by saying that "bodies expand by heat and contract by cold." In the case of the standard measures of which we have been speaking, it is definitely understood that the distance between the lines or dots on them is precisely 1 imperial yard *at a temperature of* 62°. If the thermometer rises above this, the interval exceeds 36 imperial inches. If it falls below that temperature, then is such interval less than a yard by an

amount depending upon, and calculable from, the amount of that fall. But in the work of measuring a terrestrial base-line considerable difficulty will arise from variation of temperature in different parts of the line to be measured, and hence it becomes important to use measuring rods of an invariable length. Fig. 6 illustrates the extremely ingenious manner in which the absolutely unvarying length of these rods is insured.

FIG. 6.

Reference to any work on physics will show that the linear expansion of brass is to that of iron in the proportion of 1894 to 1166 for any given increase of temperatures. Very well, then. We will suppose that $b\ b'$ and $i\ i'$ represent a brass and an iron bar respectively, connected by a steel tie, s : $b\ p$ and $b'p'$ being two flat steel tongues at their ends, moving on conical brass pivots, so as to permit them to move through small angles with the lines (bp, $b'p'$ in our figure above) square to the bars. These tongues are so adjusted that the lengths $b\ p$, $b'p'$ are to the lengths $i\ p$, $i'p'$ as 1894 : 1166, *i.e.* roughly as 5 : 3. Then a little attention will show that if the bars are made of precisely the same length at a temperature of, say, 62°, the tongues will be at that temperature accurately perpendicular to the bars, and $p\ p'$ will be at their precise length (say 10 feet) apart. If, though, we suppose that a change of temperature either expands $b\ b'$ to $a\ a'$, or contracts it at $c\ c'$, then as $bp : i\ p :: ba : ik$, and by similar triangles the points p and p' will remain at an invariable distance. Returning from this digression, we may just add that bars of this construction are laid end to end in wooden troughs in an absolutely straight line, and, if they could be brought into absolute contact, the process of measuring by their aid would be a comparatively simple one. To permit them to jostle, however, would be to introduce an element of possible serious inaccuracy. Hence they are brought as close together as they conveniently can be without coming into actual contact, and the intervening minute space is carefully measured by a micrometer microscope in a manner analogous to that previously described.

So far we have proceeded on the assumption that the bisection of the fiducial points whose distance is to be measured is made by the eye; but it is gravely doubtful if that organ is trustworthy for such a purpose beyond the $\frac{1}{100000}$th of an inch. How, then, are more minute quantities still measured? A very brief account of Sir Joseph Whitworth's perfectly marvellous machine, which measures unerringly to the one-millionth of an inch (!), may enable us to understand how this is effected. In this case the measurement is tactile and not visual, and is effected in a manner which may be summarised thus. Premising that this astonishing piece of mechanism is only capable of measuring *end*-lengths, we may say that it consists of a massive cast-iron bed, with head-stocks at each end, something like those of a lathe. Extending centrally along the top of the bed is a V-groove running the whole length between the head-stocks. In this groove slide two square bars so accurately fitted to the groove that they slide with no perceptible friction and with absolute steadiness. The ends are worked rigidly square to their sides and (what we may call) their inner ends, or those furthest from the head-stocks, are turned up in the lathe, so as to present two rigidly flat circular discs. Through each head-stock runs a micrometer screw, made with extreme care, by turning which the bars are advanced along the V-groove. Each of these screws has 20 threads to the inch. The micrometer head of the left-hand screw is divided into 250 parts: so that if we turn this forward through one division it advances the bar against which its free end abuts $\frac{1}{20} \times \frac{1}{250}$—*i.e.* $\frac{1}{5000}$th of an inch. The right-hand screw is driven by what is called a worm-wheel, or endless screw, of 200 teeth, and the screw gearing into this carries a micrometer head with 250 divisions. Hence it will be seen that the advance through one division of this last-named head must move the bar touched by the primary screw $\frac{1}{20} \times \frac{1}{200} \times \frac{1}{250}$th of an inch—in short, through exactly the one-millionth of an inch. Of course each of the micrometer heads has a fixed index, by which it can be read. Suppose, now, that we have a standard inch bar with which we propose to compare a duplicate. Our standard is constructed just like the original bars, and, as in their case, fits accurately into the V-groove in the bed of the engine. The free end of the left-hand screw is in actual contact with the left-hand end of the standard; but between its right-hand end and the free end of the right-hand screw is interposed a steel plate with rigidly parallel sides, called by Sir Joseph Whitworth a "feeler" or "gravity piece." This has two handles (something like those of a tap-wrench) which rest on two shelves fixed one on each side of the bed. When the pressure exerted by the screw is imperceptible, if we lift one of these handles the feeler drops again by its own weight. When, however, the pressure is so regulated that the feeler can be moved and yet does not fall when the handle is released, the instrument is in adjustment. We will imagine this to be the case with our standard inch bar. Then the reading of the right-hand micrometer head is accurately noted. We now turn it backwards, release the gravity piece and the standard, and take the latter out, replacing it by the duplicate to be tested. If the micrometer head goes back to the same position as it at first occupied, then are the bars of identically the same length; if not, the number of divisions gives the millionths of an inch by which they differ. The motion of the screw through *one division* of the micrometer head will release the feeler when the instrument is accurately adjusted.

Merely as a matter of course the instrument which we have been endeavouring to describe is almost infinitely too delicate for use in the workshop. At the same time, however, patterns and templates are now worked to a degree of rigid accuracy which would almost strike the engineers of the early part of the century dumb with amazement, and for the purposes of those refined measurements now imperative, Sir Joseph Whitworth has devised a somewhat more simple form of engine. This consists, in effect, of a small bed, like that of a lathe, upon which are mounted two head-stocks, very much like the poppet which carries the back centre in an ordinary turning lathe. Here the right-hand head-stock is a fixture, and the left-hand one slides along the bed by means of a screw within it, the face of the bed being graduated in inches. This graduation enables the head-stocks to be at once placed approximately at the required distance apart. The movable head-stock has a screw within it of one-twentieth of an inch pitch, furnished with a micrometer head with 250 divisions upon it. As in the case of the more elaborate instrument, however, this left-hand head, once adjusted, is a fixture, and the measuring is effected by the right-hand one, through which travels a screw also with 20 threads to the inch, whose head is graduated into 500 parts. Hence it will measure a difference of length equivalent to $\frac{1}{20} \times \frac{1}{500}$, or $\frac{1}{10000}$th of an inch. With the description of a more simple instrument still, the pocket thousandth gauge sold at Churchill's and other tool warehouses, we may conclude our account of

devices for minute linear measurement. It is illustrated in fig. 7.

Here the screw has 50 threads to the inch, and its milled head is divided, as is seen in the sketch, into

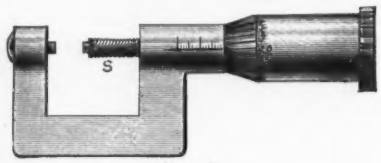


Fig. 7.

20 parts, each of such parts quite obviously corresponding to a motion end-ways of the screw of $\frac{1}{50} \times \frac{1}{20}$, or $\frac{1}{1000}$th of an inch. This is a very handy little affair, and is a good deal in use among physicists, and a most portable and convenient instrument for measuring minute lengths rapidly and conveniently.

MYTHS OF NIGHT AND WINTER.

By "Stella Occidens."

WE have all heard the fairy tale of the "Sleeping Beauty." At her birth all the fairies but one were invited. Each gave the princess some good gift. But the one who was not invited predicted good fortune only until the day the princess should prick her finger with a spindle. On this account all spindles were kept out of her sight, locked up in a room, which she was never allowed to enter. One day, as she was wandering about the castle, she entered the forbidden room, and, whilst playing with a spindle, pricked her finger. Instantly the castle fell under the spell of enchantment. The princess remained spell-bound at the spindle, and everyone in the castle remained as they were at the moment when the accident befell.

After several years had passed a dense forest hid the castle from sight, and it seemed as though the Sleeping Beauty might sleep on for ever. But a prince, who had lost his way whilst hunting in the forest, perceived the castle, and sought to see who lived there. Entering, he found the Sleeping Beauty, and as he kissed her the spell of enchantment was broken. She instantly awoke from her long sleep, and all was restored to life and animation in the castle.

This story corresponds strangely with a German legend of an ancient town on the Rhine, called Xanten. Here stood the Castle of Nibelungen, and here Siegfried, the dragon-slayer, was born. Tiring of the quiet life at home, he wandered forth in search of adventures. Among other exploits he destroyed a dragon. He threw the carcass in the fire, and a stream of fat running out, a little bird, sitting on a tree above him, sang to him that if he bathed in the dragon's blood he would become invulnerable. He did so, but one spot on his shoulder was untouched by the oil owing to a leaf which had fallen from the tree. Siegfried travelled down the Rhine until a storm drove him on a rocky coast. His horse brought him to a castle surrounded with flames, through which the little bird told him to leap. After passing through the flames, the little bird told Siegfried that he would find a spell-bound maiden, under the power of a magician, shut up in a castle. Siegfried entered the castle. The stillness of death was on all the inmates. The servants were in the position in which they had been at the moment of enchantment: the cook before the fire, the butler pouring out a glass of wine, the groom before the horses, and the very animals immovable before the mangers. At length Siegfried entered the hall, where he found a beautiful maiden sleeping on a couch, and bound with brass bands. Siegfried cut the bands, and, kissing the maiden's rosy lips, instantly released her from the spell of enchantment which had endured for a century.

One would scarcely think of associating legends such as these with nature myths, yet the wintry sleep of nature and the sun sinking to rest in the caverns of night, have been symbolised by innumerable stories such as these, of spell-bound maidens rescued by princely heroes. In the story of the "Sleeping Beauty" the prince is Spring, who rescues the spell-bound maiden (or the earth) from her deep slumber beneath the icy mantle of winter. Locked in her ice-palace, the Sleeping Beauty is restored only to life and activity when the first bright rays of the Sun-god awaken her. Every nation, indeed, has a myth corresponding with the above legends, though differing somewhat in the minor details.

In the "Arabian Nights" we find the well-known story of Codabad and his brothers, over whom his father placed him in authority. Codabad at their urgent request allowed them to go out for a day's hunting. When several days had passed yet they did not return, the father made Codabad go in search of his brothers, threatening the utmost weight of his resentment if he did not bring them safely home again. He disguised himself as a shepherd, and started on his travels. He arrived at a plain of great extent, in the middle of which he saw a palace of black marble (the mansion of Night). When he drew near, he saw a beautiful lady at one of the windows, who entreated him not to enter. "Alas, young man!" she said, "escape as fast as possible from this fatal place, or you will fall into the hands of the monster who inhabits it. A cruel black giant (Night) who feeds chiefly on human flesh, resides in this palace; he seizes on all persons whose ill-fortune conducts them to this plain, and shuts them up in his dark dungeon, whence they are never let out but to be devoured by him."

Codabad asked the fair prisoner if he could not save her from such a fate, but whilst he was yet speaking the giant approached them. He was a man of enormous size and dreadful aspect, and wore such a large and mighty scimitar that no one but himself could use it. However, Prince Codabad drew his scimitar, and stood upon the defensive. The giant would have passed him unnoticed, telling him to move out of his way, but Codabad struck the giant such a blow on the knees, that he fell on the ground, yelling with pain. He struck at Codabad with his great scimitar, but the Prince aimed a blow at his right arm, and cut it off. The giant fell, and the earth quaked beneath him. Codabad completed the victory by chopping off the giant's head, and the fair lady was free. The rest of the prisoners in the castle were released, and among them Codabad found his forty-nine brothers.

This story somewhat resembles the account of the Panis in the Rig-Veda, who are genii of Night and Winter. They steal the cattle of the Sun, and carry them toward a dark cave in the east. Sarama, the creeping Dawn, is sent by Indra to try and recover them. The cattle of the Sun are the clouds or cloud-maidens. In the myth of the Argonauts they appear as the Golden Fleece, carried to the east by Phrixos and Helle, who are themselves Nibelungs, or "Children of the Mist" (Nephle), and are there guarded by a dragon. In all these myths a treasure is stolen by some power of darkness, and recovered by a hero of light who slays the demon.

Among the Nibelungen lays, we find the famous myth about Fafnir, who steals the Valkyrie Brynhild, and keeps her shut up in a castle on the Glistening Heath, until some champion shall be found powerful enough to rescue her. The hero who saves her is Sigurd, the Northern Achilleus.

Riding on his deathless horse, and wielding his resistless sword Gram, he forces his way into the castle, slays Fafnir, and recovers the Valkyrie. The Valkyries are also cloud-maidens, or Nibelungs.*

There is some resemblance to be traced between the horse which bears Sigurd into the place where Brynhild is imprisoned, the wooden horse which enters Ilion, and the Druidic steed which leaps with Sculloge over the walls of Fiach's enchanted castle.†

Among the Greek legends we have the account of Odysseus, who is ensnared by Calypso, the nymph of darkness, and kept in bondage. Then we have the story of Hercules, who, whilst reposing by the banks of the Tiber, has his cattle stolen by the three-headed monster Cacus. He drags the cattle (or clouds) into a dark cavern (Night), and does not recover them until he breaks open the entrance of the cavern and destroys the demon. Professor Fiske tells us that the three-headed monster is a near kinsman of Geryon's three-headed dog Orthros, and of the three-headed Kerberos, who guards the dark regions below the horizon. He is the original were-wolf or Rakshasa, who steals the bright cattle of Helios, and hides them in the black cavernous rock, from which they are afterwards rescued by the Schamir or lightning-stone of the solar hero.‡ Then we have the beautiful myth of Endymion, his name being one of the many names of the Sun, but having special reference to the setting-sun. Endymion sank into an eternal sleep in the Latmian Cave, or cave of Night, after living but one day. Selene the Moon sees him, loves him, and keeps him captive. In the poetical language of Elis, people said, "Selene loves," instead of "it is getting late"; "Selene embraces Endymion," instead of "the Sun is setting," and "the Moon is rising"; "Selene kisses Endymion into sleep," instead of "it is Night."§

This myth reminds us of the story of Tannhäuser, the Frankish knight, who lost his way whilst travelling at twilight past the Hörselberg. "He saw a white gleaming figure, of matchless beauty, standing before him, and beckoning him to her." He left his horse and disappeared behind the moonlit cliffs, lured by Venus Ursula, the fair goddess of Night. She kept him captive for seven years, and then, longing once more to return to his old home, he prayed to the Virgin Mother, who released him. Finding no priest who would absolve him from his sin, not even the Pope, whom he journeyed to Rome to see, he returned in despair to the Venusberg, and has never been heard of since.

Even the story of Rip Van Winkle, who wandered away among the Catskills, lured by the gnomes, and returning after a sleep of twenty years, is unrecognised and forgotten by his own wife and child, had its origin in the nature myths of Winter and Night.

(To be continued.)

* "Myths and Myth-makers." Fiske, p. 132.
† Ibid. p. 187. ‡ Ibid. p. 118.
§ "Chips from a German Workshop," p. 80. Max Müller.

AMERICANISMS.

By Richard A. Proctor.

Fence-riding, the art of remaining on the fence (see December number). It is to be carefully distinguished from riding on a rail, though a fence-rider not unfrequently ends his career by being a rail-rider.

Fetch. Bartlett notices the nautical phrase "to fetch up all standing," and thence simply to "fetch up," meaning to stop suddenly, as an Americanism—though this expression is probably much commoner in England than in America. But he altogether overlooks the Americanism, "to fetch," as meaning to influence strongly. The expression is used provincially in this sense in England; but it is commonly so used in the States, even by educated persons. Thus I remember a college professor telling me how unwilling he had been to accede to a publisher's request that he should write a treatise on the sun, till told that if he would not another person, whom he knew to be incompetent, would be invited to write the volume. "That *fetched* me," he said with emphasis; meaning that that was an argument he could not resist.

Few. Used for "a little," may be a shade commoner in America than in England. But so common a Cockneyism can hardly be called an Americanism.

F.F.V., First Families of Virginia.—A term used under the amusing delusion that the original settlers in Virginia were all, or nearly all, descended from the noblest families (in the conventional sense) in England. There were five or six such among the first two hundred; and not all even of those few left any to succeed them. But the great majority were much more useful settlers. The first wives of the settlers were sent out as assorted samples, purchaseable at as many pounds of tobacco as they would bring. They averaged 120 lbs. of the best Virginian. The next lot brought 150 lbs. per head. The First Families delusion, however, does no harm. Perhaps in some cases, by suggesting the thought that *noblesse oblige*, it does good, like the corresponding idea in England of which our Thackeray has made amusing use. The *New York Tribune* asserted in August 1861, that F.F.V. had come to stand for Fast Footed Virginians, because of undue alacrity displayed before the enemy. We had supposed in England that the Virginians at Bull's Run had been fast-footed with face forward to the foe. But the newspaper writer may have been too far from the field to know how the matter really stood, or how the foemen on either side really ran.

Fice, or Fyse. In Kentucky a small dog or cur. Nares has the word in his glossary in the form "fyst," as "a foisting hound or cur of the lap-dog kind."

Figure, To. As, "you may figure on that," meaning you may count on that. Also, but less commonly, figure is used for thinking over; as "figure on that"—"think of it." This, the only meaning given by Bartlett, is probably the original meaning of the expression. He gives the usage as Western, but it is quite commonly heard in New England.

Filibuster. From the Dutch *vrijbuiter*, German *freibeuter*, English *freebooter*, the French *flibustier*, or the Spanish *filibustero*. The word has come into tolerably free use in America, especially South-west. It may be understood as the equivalent of "freebooter." The following passage from a letter written by General Henningsen to Senator Toombs in 1857 gives a good idea of the use of the word, both as noun and as verb, and is worth reading for other reasons:

"What was Moses but a *filibuster*, whose mission was to dispossess tribes retrograding (or whose civilisation was corrupting before matured), and to plant in their stead another people, whose subsequent annals show them to have been at least in nowise superior to our own? What were the Normans from whom the sovereigns of Great Britain affect to derive their descent, and a portion of their title to the crown, but *filibusters*? What the Pilgrim Fathers but *filibusters*? What State, what territory in this Union has not been *filibustered* from the Indians, or purchased from those who had *filibustered* it? Have ever five years elapsed down to the present time, since the landing of the Pilgrim Fathers, that some of the Monarchies of Europe have not, somewhere, been *filibustering* something?"

XUM

Filibusterism. An elegant derivative.

Fillipeen, or Philopeen. It seems probable that this word "Fillipeen," certainly derived from the German *Vielliebchen*, reached us in England from America, where German words, as well as German ways and customs, are more common in social and family life than in the Old Country.

Fill the Bin, To. To answer to a description, be the person asked for, or the like. Are you so and so? says question, "and then comes answer like an Absey book," "I fill the bin."

First Swathe. Equivalent to our English slang "first chop."

Fits. "To give any one fits," sometimes "particular fits," means to make him singularly uncomfortable, or to give him startling evidence of disgust at something or other he has done. The expression is often heard now in England, but I fancy, from the frequency with which it is heard in America, that it had its origin over the water. Our English slang equivalent would be "I'll make him look nine ways for Sunday"—that is, I presume, for Sabbath rest. The literary reader will immediately recall here the introduction of this expression into a description (in the classical pages of *Punch* nearly thirty years ago) of a fight between Tom Sayers and Bob Travers, where we were told how Tom gave Bob a straight one which

> Made him look nine ways for Sunday and finally fail to perceive it.

Fix. A predicament or condition. To be "in a fix," as equivalent to being in an awkward situation, is about as commonly heard in England as in America. But I think the origin of the expression, regarded as a form of slang, is Transatlantic.

Fix, To. The use of this word in the sense of arranging, and where the idea of fixity is not at all implied, would seem to have arisen from some confusion between fingency and fixation—as if the word had the meaning of the Latin *fingo, fingere*, instead of that only of the Latin *figo, figere*. At least I know of no use of the word "fix" in America which would not fairly represent the meaning of one or other of the two verbs *fingo* and *figo*. It certainly has a strange effect to hear "fix" used in one of the wrong senses—as "Let me fix that feather," when the idea is to make it wave naturally; "I will fix the table," meaning "I will lay the cloth and set the plates, knives, forks, &c.;" or still more oddly when, as I heard it used only a day or two since, in reply to a child's cry, "My dress is caught, I wish you would loosen it," the answer comes, "Wait a moment and I'll fix it."

PUBLIC SCHOOLS ATLAS.*

BETTER provision has been made in this work for teaching our public school boys geography than has been made to teach them Latin and Greek in all the nonsensical grammars written for them from the days of the Tudors until the last most monstrous wrong was done the young folk by the "Public Schools Grammar," published a few years ago. Why geography should be taught sensibly and languages in a blunder-headed manner it were difficult to say; but certainly it is fortunate that the preparation of books on geography did not fall into the hands of the wiseacres who discovered that extremely difficult logical questions involved in grammar were fit food for boyish minds. (Puzzle out, reader, the true significance of a few such words as *declination, case, genitive, ablative, adjective, conjugation, supine, gerund*, &c., and the complex nature of the problems you were *supposed* to deal with at school will be clear to you.) Because, if geography had been dealt with in the same way we should have had our boys learning the formulæ for the barometrical determination of heights before they were told the heights of the various mountains on the earth, or studying the differential equations for fluid motion before they learned the courses of the principal rivers. (This may seem extravagant; but ask the fifty leading philologists of the world to tell the boys who learn of *supines*, for example, the logical significance of the word—and why those particular verbal forms might not equally have been regarded as *prones* or *uprights*—and guess from their replies whether the logic of grammar is not as far from being fit teaching for young folk learning languages as mathematical formulæ from serving as a proper introduction to geographical matters.)

In the book before us we have geography illustrated in a very simple and attractive manner. The scale of the maps is adequate. They are not so overcrowded with names that the wood cannot be seen for the trees. The rivers are clearly and effectively represented from their sources, and the positions of towns with reference to them and to the sea-coast have been very carefully indicated. There are not too many maps, yet there are enough for the purpose aimed at, and the atlas is cheap.

As regards details, the following features seem decided improvements on the old plan. The names of countries and of their chief divisions have been engraved more compactly than of old, the initial letter of each chief word being relatively larger than usual; the names are engraved horizontally wherever this has been possible; and with one exception (the United States) the maps have not been folded.

To one feature of the maps an exception must be taken. While the outlines of the continents and islands, the courses of rivers, and the positions of towns, are printed in blue, the meridians and parallels, the outlines of countries and counties, and the names of places are printed in black. So far as the colours are concerned this arrangement is convenient enough. But when we remember how the two printings are necessarily managed, and that by no possible arrangement can exact "registering" be obtained (simply because the wetted paper expands irregularly, and is irregularly compressed at each printing), we see that the meridians and outlines of countries should be given by the same printing as the rivers and the outlines of continents—necessarily, therefore, in the same colours. The names and the map frame might be separately printed (black), and no harm done, but the outlines of countries and counties cannot be safely so printed, and for the meridians and parallels to be separately printed is seriously objectionable. These are, in effect, the measuring marks on maps, and to have them wrong is to have the whole map wrong. When we have mentioned that in our copy, Greenwich, owing to defective registering, appears to be measurably east of the first meridian, which we know is the meridian of Greenwich, the fundamental character of the defect will be recognised. Of course in another copy Greenwich may appear west of the meridian, and in some copies may chance to be just right. But this does not mend matters. In every copy some maps must have every single town shown in wrong longitude or latitude.

The maps of this atlas are of course drawn like those of

* "The Public Schools Atlas of Modern Geography, in 33 Maps." With an introduction by the Rev. Geo. Butler. New edition. Longmans & Co., London. Price 5s.

all other atlases, on the projections which were employed two centuries ago, which served very well at a time when men had very vague ideas of the true outlines of continents and countries. Spain, as it appears in the map of Africa, is quite another Spain from Spain in the map of Europe. And so with many other cases. But probably in three or four centuries more truthful projections will come into use.

Gossip.

By Richard A. Proctor.

Professor Newton, of Yale College, has advanced a theory of the origin of meteors, which Professor Young, of Princeton College, has endorsed, apparently giving up Schiaparelli's. According to this theory, meteors are the fragments broken off (when or how the deponent sayeth not) from comets. The theory labours under the slight objection of explaining none of the characteristics either of comets or of meteors. In fact, most of the theories of comets and meteors which are at present chiefly in vogue—I mean in regard to numerical acceptance—are like the Hindoo theory of the earth's stability, according to which the earth stands on an elephant, the elephant on a tortoise, that on something else, and so on *ad infinitum*. Thus Schiaparelli taught that meteors travel in the tracks of comets, that comets were meteor streams gathered out of the star depths, and meteor streams got into the star depths out of somewhere else, leaving us there in infinite uncertainty. Professor Newton interpolates a link, which still leaves the perplexity at the farther end of the chain undiminished—meteors, it seems, follow in the tracks of comets because they were chipped from comets. Were we not better off with Schiaparelli's theory pure and simple?

* * *

The *Times'* record of "Science in 1886" is manifestly from the versatile and discriminating pen of Mr. J. N. Lockyer. The progress of astronomy, in which I naturally take chief interest, is full of promise. It appears to be included in two statements. First, a solar eclipse occurred in August, "to observe which a party was sent from England under the direction of Mr. Lockyer;" and secondly, "the laboratory for solar physics at South Kensington, under the superintendence of Mr. Lockyer," is still "groping for a solution of the great problem in solar physics which Mr. Lockyer is understood" (it is really Clarke's, of Cincinnati) "to have started." The "fascinating theory," as Mr. Lockyer calls it, will soon, he is convinced, be established: this theory being that "It only requires heat enough to convert everything into glowing hydrogen." One recalls just here the theory of the fascinating next-door gentleman, on the garden wall, in "Nicholas Nickleby," who promised that, under certain conditions, all should be "gas and gaiters." Gaiters do not appear in Mr. Lockyer's theory, but there may be reference to them in the remark (not apparently justified by the recognition of hydrogen as the element which is in and through all things) that the solar physics work at South Kensington is evidently "very excellent," and "pregnant with practical issues for humanity." It is to be hoped so, for a goodly sum is paid each year for the work; and some men of science have been unkind enough to say that nothing worth the paper on which it has been recorded has been done by the solar physics folk. But their superintendent ought to know; and since he says their "very excellent work is pregnant with practical issues for humanity," we must possess our souls in patience and wait to see what this singularly mixed metaphorical promise may imply in the way of performance.

A few days ago my partner at whist had a hand with no card above an eight. Within two days I was told by a whist-player, at one of the places where I was lecturing, that he had had such a hand, and was asked if I had ever heard of a hand so poor. The coincidence was strange enough, but hands even poorer are on record. "Pembridge" mentions a hand with nothing in it above a five, and only one five. I think he mentions Surbiton as the place where the hand was dealt—if that matters. If the chance of a hand with nothing above an eight is required, we get it by noting that, while the number of possible hands is

52 . 51 . 50 . 49 . 48 . 47 . 46 . 45 . 44 . 43 . 42 . 41 . 40

(which call A), divided by the product of the first thirteen numbers, the number of hands with no card above an eight is

28 . 27 . 26 . 25 . 24 . 23 . 22 . 21 . 20 . 19 . 18 . 17 . 16

(which call B) divided by the same product. Hence the chance of a hand with nothing above an eight is represented by B÷A. This I find to be 1 in $16959\frac{146}{171}$; so that the odds are $16958\frac{146}{171}$ to 1 against such a hand being dealt to a given player at any given deal.

* * *

A correspondent sends a singularly evolutionary attack on evolution from the *Christian World*. Mr. S. R. Pattison, under pretence (at least, so I suppose) of attacking evolution, tries to show that "there has been an unfolding of the Divine plan throughout the ages, by steps, not by an inclined plane, every step being a separate creation." This, of course, is evolution pure and simple, despite the word "creation." A man's son differs in finite degree from the man, and is in that sense a separate creation; and no evolutionist believes in an inclined-plane process of development which would involve an infinite number of generations. Mr. Pattison adds that metaphysics knows nothing of evolution in the nature of a force from without. Neither does science, evolution being in its very essence a process working from within.

* * *

I have sometimes wondered that no one seems to have recognised as the main theme of the synoptic gospels—coming again and again into prominence—the absurd impertinencies of humbugs and hypocrites, and the quaintly humorous but crushing way in which they were dealt with.

* * *

Mr. E. L. Garbett, with whom I have had some slight "passages" in past times, having studied the prison-cell puzzle and the Josephus puzzle as presented at p. 43 (Knowledge for December), writes as follows:

> These two puzzles are marvellously parallel. Of the 36-cell puzzle, Mr. Proctor "believes" there is a solution. Well; just colour the cells chessboard-fashion, and you see that every move must change your colour. You are to visit all the cells, therefore to make 35 moves. An odd number of moves must (like a single move) change your colour. But A and B are of the same colour! Yet Mr. Proctor "believes" there is a solution—that is, that you can get from A to B by 35 moves! That is about equivalent to believing that such a book as Josephus's "Antiquities," under patronage of and circulated by command of an imperial Cæsar, could have forgeries interpolated. A man who can believe either of these must be about the most credulous of miracle-swallowers alive.

* * *

Mr. Garbett's style is a trifle crisp. One is reminded of the schoolboy manner, "Well, you *must* be a thundering fool to believe that." An odd thing, too, is that I had not myself thought it necessary to point out to the readers of Knowledge, not wishing to insult them, what Mr. Garbett so kindly points out to me. It seemed too obvious. It

was clear that the solution must be by a dodge of some sort. I was far too busy to give any attention to the puzzle when I threw it in, just as it stood, with my Gossip. But the moment one looks (anyone, it would seem, except Mr. Garbett) for the solution, it is as obvious as that, without the dodge, no solution would be possible.

* * *

As for the Josephus puzzle, the question of interpolation has in reality very little to do with the matter. Nearly every commentator of repute has admitted that the passage relating to Jesus is an obvious and a most clumsy forgery; and if the passage relating to John the Baptist is not a forgery, then, since it is entirely inconsistent with the Gospel narrative, we get a more difficult puzzle by its admission than when we reject it. As for the patronage and command of an imperial Cæsar (not a Christian), how that would prevent interpolation centuries after that imperial Cæsar was dead and turned to clay, Mr. Garbett might find it difficult to show. That interpolations and forgeries of the most unscrupulous kind were rife in the third, fourth, and following centuries, that as Eusebius, prince of liars, proclaimed that it was held right to forge and lie for the glory of Christianity, we know; and we know no reason why Josephus or Tacitus, or any non-Christian writer of the critical first and second centuries, should have escaped the process, no matter what imperial Cæsar had patronised them or commanded them to prepare the treatises they wrote.

* * *

But the passages regarded by all competent critics as interpolations in Josephus, and those regarded by many competent critics as interpolations in Tacitus, would if accepted prove nothing beyond what is tolerably well known without them. It would indeed be preposterous to assert on the strength of the doubtful passage about Jesus Christ that Josephus regarded him as the Messiah, for Josephus manifestly (fifty pages could be cited to show this) regarded his countrymen's hopes about the coming of the Messiah at that time as fallacious and dangerous. But if Josephus really wrote and really believed it (which is absurd) that would no more help to establish the belief ascribed to him than Tacitus's description (supposing the passage not interpolated) of the Christians as malefactors would prove them to have been such.

* * *

Some correspondents, by the way, have dwelt rather strongly on Renan's acceptance of the more than doubtful passage in Josephus relating to Jesus. The fact that Renan does not refer to the question whether the passage is genuine shows that he had not critically examined the matter. He refers to the passage in such a way, too, as to imply precisely that view of the puzzle which I have indicated. His words are: "*Joséphe, né l'an* 37 *et écrivant sur la fin du siècle, mentionne son exécution*" (*l'exécution, c'est à dire, de Jésus*) "*en quelques lignes, comme un évènement d'importance secondaire.*"

* * *

Of course the real Josephus puzzle resides in the circumstance that many of the facts related by him as occurring thirty or forty years after the alleged date of the crucifixion seem to have been worked into the narratives given in the synoptic gospels. The puzzle to be solved is to explain how this may have happened through sheer coincidence, or, if this is impossible, then to show whether Josephus, writing in the first century, borrowed for his history events which had really happened thirty years before the time he assigns to them, or whether the borrowing was the work of the synoptical evangelists writing some half a century later.

By the way, in the second paragraph, on the second column of p. 50, there is a rather curious blending of statements. After "a work with which Enoch had nothing to do" there should have been a full stop. Then this "Matthew appears to have left a record in writing of the teachings of Christ, which are quoted—probably from Matthew's record—in the gospel *according to*, certainly not *by*, Matthew. This gospel appeared in all probability," &c. This sets the paragraph right, except that in the seventh line from the end, "The Gospel" should be "this gospel."

* * *

"A Square" sends a "wail from Flatland," or, in other words, the well-known Tridimensional, whose romances of Flatland have touched many students of quadri-dimensional mathematics, has sent a letter describing the anguish of "A Square" imprisoned in such cells as Mr. Garbett failed to find escape from. We would publish this piteous lamentation were more of our readers quadri-dimensional; but the number of such readers is so limited, that we must ask the ingenious author to forgive us if we refrain. Will he kindly regard his letter as printed in planes persistently perpendicular to those of the pages of Knowledge.

* * *

W. E. H. sends some remarks on the Knight's Tour at Chess. The subject has been, however, so exhaustively treated already that we must not touch it. We are rebuked already for allowing those Fifteen charming School-girls to disport themselves in our pages.

* * *

A military correspondent points out that the six lines enclosing ten spaces, if set in the manner shown in fig. 6, page 9 (Knowledge for November), can be arranged so as to give a symmetrical figure, by making the large outer triangle and the centre triangle equilateral. The figure thus obtained does not fulfil any of the conditions of axial symmetry to which I referred. The symmetry is of the three-legged Manx-arms description. My arrangement has this kind of symmetry, *plus* tri-axial symmetry.

* * *

The same correspondent expresses a wish that the first page of the cover of Knowledge should bear no advertisements, but be wholly given to title and the contents. He says, "none of the best periodicals have advertisements, to my knowledge, on the front of the cover, but the contents are printed in plain type, the articles and authors being distinguished by a different type, so that one can see at a glance what the magazine contains: this seems to me most necessary." The cover of Knowledge is nearly the same in the monthly form as it was in the weekly, and our correspondent is aware that the *Athenæum* and *Academy*, to mention no other weeklies of similar standing, have advertisements on the first page of cover. It did not seem worth while to change, especially as on the stalls only a few inches near the top of quarto publications are displayed. Any one who has to take out the magazine to see the front page in full can readily at the same time see the contents as at present printed. The change recommended would involve a considerable yearly loss; and already the expenses of Knowledge run so close to the possible proceeds of its sale (we *did* have it for a time so that the more copies were sold the greater the loss) that a change of the kind is practically impossible. Let Knowledge be compared, simply in quantity of matter, with any periodical of the same character, and it will be recognised how we are handicapped.

* * *

Mr. Alfred Brown has succeeded in trisecting the angle, "and can give geometrical proof of the same." He desires

to know what is the value of the discovery to me for publication. The angle can be trisected geometrically in hundreds of ways. In my "Geometry of the Cycloidal Curves" there is a trisection. The difficulty is to trisect the angle by a method which shall involve the use only of the line and circle—that is, ruler and compasses. Supposing Mr. Brown had managed this, which is equivalent to supposing that he had discovered a way of making steel rails out of cheese-cakes, the discovery would be worth a sum which may fairly be represented by x sovereigns, where x is the root of the equation, $x^2 + (1{,}000)^2 = 0$.

* * *

The following words of a letter I have just received from a friend in London, who kindly sifts out all Knowledge correspondence, and forwards to me only what is worth forwarding, may save a certain class of correspondents trouble:

> Some kind correspondents are solicitous about your soul, and add to the store of the waste-paper basket.

My friend evidently shares my opinion that any one who imagines it his duty to turn from the culture of his own soul-business to inquire into the soul-business of others, is necessarily what the profane call a humbug, and probably a hypocrite.

Reviews.

The Functions of the Brain. By David Ferrier, M.D. (London: Smith, Elder, & Co. 1886.)—Dr. Ferrier's work on the functions of the brain is already a classic on the subject with which it deals. This second edition has been largely rewritten, and much new matter has been added, bringing the book up to date in every particular. The larger portion consists, as before, of Dr. Ferrier's own experimental investigations into the localisation of faculty in the various regions of the brain; but these are expanded into a systematic exposition of the entire subject by the addition of much recent physiological and pathological material. As yet, our knowledge in this direction is of the inchoate sort which, for the most part, interests specialists alone; the results are still few and hazy; the faculties localised are vague and psychologically unimportant; and only students of nervous phenomena are likely to wade through the long details of Dr. Ferrier's operations on dogs and monkeys. The electrisation of portions of the hemisphere was followed, as a rule, by special movements of the limbs or other relatively uninteresting motions. Cerebral topography, in fact, must reach far higher planes than this before it becomes a matter of popular study. The results so far are immensely valuable, but valuable as first indications only. We shall have still to wait a long time before we get a real knowledge of the way the brain works and the parts performed by its several portions.

Modern Methods of Illustrating Books. (Elliot Stock.)—This book is the latest addition to "The Book Lover's Library," edited by Henry B. Wheatley, and although the title-page does not bear any author's name, Mr. H. Trueman Wood's name appears on the cover, and he is presumably mainly responsible for the contents. In the preface he says that he has endeavoured to avoid technical details except such as were necessary to make descriptions intelligible, and, with a view to help those who may require fuller or more special information, he has added in an Appendix a list of a few works where the best information can be obtained. Much valuable and interesting information is given as to various methods of illustrating books, but the main interest of the work is in the description given of some of the many modern "processes" which are now so much in vogue, some of which bid fair to supersede wood-engraving for certain purposes. The information given as to the methods pursued by the inventors of these various processes is necessarily limited, as they are mostly worked in secret, but the whole of the work is very interesting to those engaged in the production of books, whether as authors, printers, or publishers.

Hazell's Annual Cyclopædia, 1887, *containing nearly* 2,000 *Concise and Explanatory Articles, on every Topic of Current Political, Social, and General Interest referred to by the Press and in Daily Conversation.* Edited by E. D. Price, F.G.S. Revised to February 7, 1887. Price 3s. 6d. (Hazell.)—We give the title of this book in full in order that we may say at once that the contents fully justify it. There is scarcely any subject of current interest that we have not found mentioned, and, judging from those subjects on which we presume to be competent to speak, we must say that the details given are exceedingly accurate. We cannot speak too highly of the general conception and execution of the work, and shall now look upon it as an indispensable supplement to the indispensable "Whitaker." To illustrate this we will take some subjects at random, on all of which in "Hazell" are given very useful information, but on none of which can we get any help from "Whitaker": viz., *Kyrle Society, Socialism, Bi-metallism, Jezreelites, Tithes, Noms de Plume, Noms de Théâtre, Society for Psychical Research.* One of the most interesting features is the series of short biographies of living celebrities, both English and foreign; but the most useful articles, we think, are those devoted to subjects of current interest, but which are frequently those on which the generality of the public have little accurate information. We may quote as illustrations the articles on Socialism, Tithes, and Bi-metallism, mentioned above.

The World of Thought. A Novel. By the Author of "Before I Began to Speak." (London: Simpkin, Marshall, & Co.)—*Landon Deecroft.* A Socialistic Novel. By Laon Ramsey. (London: William Reeves.)—We have classed these two books together as, probably, two of the worst novels it was ever our misfortune to be compelled to wade through. Wide as the poles asunder in some respects, they have this in common, that they are written in the most bombastic and inflated language possible, and the ordinary elements of human interest, incident, surprise, or plot are practically absent in both.

As Mr. Landon Deecroft is a Socialist, who wears "his black hair combed back over a finely-shaped head" (who does not recognise the blatant platform speaker with his hair combed back?), it is not surprising that he rants through whole pages and chapters of the book. Of course, this Socialist is a kind of angel on earth, while his partner, poor man, who has only worked and saved money, is exhibited as a mean and contemptible creature, because, apparently, he has an objection to lend his capital without interest. Those who can keep awake over the stilted maundering of Landon Deecroft, Annie Binham & Co. (we confess, in the most sacred confidence, that we could *not*), may learn how marvellously Mr. Deecroft's Communistic farm succeeded—on paper—in one of the Northern States of America.

In what grade of society the author of "Before I Began to Speak" has moved it would be exceedingly difficult to determine, so uncommonly vague are his ideas of the manners and customs of English ladies and gentlemen. We wonder who told him that a guest specially invited to a house to meet and thank a sick man could or would ever send up his card to him! Or, again, in what social rank it would be tolerated that people should break off a conversation to produce pocket-

XUM

books or diaries, and read out Tupper-and-water by the yard! Why does not the writer of such stuff study Thackeray and Trollope, and learn how people in the position of his own puppets do act, and speak, and think?

National Lessons from the Life and Works of Carlyle. By Alfred Francison. (London: London Literary Society.)—Mr. Francison's "Lessons" consist in upwards of one hundred pages of sermonising; of, sooth to say, rather a dreary character. If we understand him (of which we are not overweeningly confident), he admires what Carlyle did, but not the motives which prompted him in doing it. Moreover, he is an admirer of that extremely self-assertive, not to say "bumptious," person, Mr. Ruskin. It is to be deplored that the acquaintance either of our author or of his compositor with the spelling of words not strictly English appears to be limited. Thus we find it asserted that "L'amour et la fumée ne peuve se *chacher*," the verb which we have italicised being as "the French of Stratford-atte-Bowe." Again, on p. 14, and again on p. 20, "Sartus resartus" appears, as do "magna char*ters*" on pp. 25 and 28. Might we further venture to hint that the famous poet spelt his name Shelley, and not "Shelly," as rendered by Mr. Francison on p. 39?

India Revisited. By Samuel Smith, M.P. Reprinted from the *Contemporary Review.* (London: Wm. Isbister. 1886.)—The man who is to discuss Indian affairs with any claim to attention should belong to no English political party. In the pamphlet before us Mr. Smith tries very hard to treat his theme in an impartial and judicial spirit, but it is abundantly evident that he has been sedulously crammed by the "Baboos," and sees the problems which await solution in our mighty Eastern empire almost wholly through the spectacles which those artless beings have provided for him. His remarks on the Drink traffic may, however, be read with advantage.

Euclid Revised. Books I. and II. By R. C. J. Nixon, M.A. Clarendon Press Series. (Oxford: Clarendon Press. 1886.)—Of all the attempts to improve the imperishable work of the mighty Alexandrian geometer, Mr. Nixon's appears to us to be the most successful. By the simplification of some of the methods of proof he is enabled to omit certain propositions altogether; although, in view of the omnipotent examiner, these are subsequently given at the end of each book. His addenda, exercises, and appendices are very notably good.

The Public School Chemistry. By J. H. Anderson, M.A. (London: Cassell & Co. 1886.)—Mr. Anderson well describes his book as "a syllabus for the master and an abstract for the boy." It is essentially one to teach from, and differs in this respect from the mass of elementary works in chemistry which are so abundant. The familiar pictures of the retort, the pneumatic trough, the spirit-lamp—*et id genus omne*—are wholly absent from its pages; in fact, it is intended to supplement and not replace the instruction given in class or at lecture. Its value for this purpose is undeniable.

We have also received from Messrs. Griffith, Farran, Okeden & Welsh *Pettitt's Shilling Folio Scribbling Diary, The Week,* and *Pettitt's Desk Remembrancer,* each in its way useful for noting current events, reminding their possessor of his appointments, &c. They are cheap, and well got up. From Messrs. Moffat & Paige we have *Digesting Returns into Summaries,* by E. J. Henchie and J. Hall, a Civil Service cram book; and six parts of the *Home Lesson Book to the New Explanatory Reader,* which seems well calculated to enable children attending Board and National schools to get up their lessons intelligently.

THE FACE OF THE SKY FOR MARCH.

By F.R.A.S.

THE persistent observer of the sun may be rewarded by the occasional view of spots, but they are becoming more infrequent, and a really fine one is a rare object. The zodiacal light may now be well seen after sunset in the west, as a blunt ill-defined cone of light, as bright as, or brighter than, the Milky Way. The night sky will be found depicted on map iii. of "The Stars in their Seasons." Minima of Algol ("The Stars in their Seasons," map i.), will occur at 11h. 43m. P.M. on the 2nd; 8h. 32m. P.M. on the 5th; 1h. 25m. A.M. on the 23rd; 10h. 14m. P.M. on the 25th; and 7h. 3m. P.M. on the 28th; and at other times where either the light of the sky or the inconvenience of the hour renders their observation difficult or impossible. Mercury is an evening star during the first half of March, and during the first week or so may be picked up with the naked eye just above the western horizon after sunset. He attains his greatest eastern elongation from the sun (18° 9′) on the 5th. Venus is an evening star, too, and may in like manner be seen in the west directly after sunset. She is just now a singularly uninteresting object for the observer with the telescope. Mars is invisible. Jupiter souths during the early morning hours, but he rises soon after half-past 10 o'clock at night at the beginning of March, and rather more than two hours sooner at the end of it. It will be found just above the star λ Virginis ("The Stars in their Seasons," map v.) by those who care to sit up, or get up, to observe him. The visible phenomena of his satellites occurring before 1 A.M. are necessarily few. Such of them, as (presupposing clear weather) may be certainly seen, are as follow: On the 5th, the ingress of the shadow of satellite I. on to the planet's disc will happen at 12h. 9m. P.M. On the 6th, the same satellite will reappear from occultation at 12h. 38m. P.M. On the 11th, the shadow of satellite II. will pass off at 11h. 31m. P.M. On the 13th, satellite I. will disappear in eclipse at 11h. 25m. 1s. P.M. On the 14th, the egress of the shadow of satellite I. will occur at 10h 44m. P.M., followed at 11h. 32m. P.M. by that of the satellite casting it. Satellite III., which is also on Jupiter's face, will leave his limb at 11h. 38m. This phenomenon, for the reason so often given in this column, should be carefully watched. On the 18th, the ingress of the shadow of satellite II. will happen at 11h. 28m. P.M. On the 21st, the shadow of satellite I. will enter on to Jupiter's limb at 10h. 25m. P.M. At 10h. 38m. P.M. the shadow of satellite III. will follow it. At 11h. 7m. P.M. satellite I. itself will commence its transit across the planet. At 12h. 37m. the shadow of satellite I. will leave his opposite limb, as will the shadow of satellite III. six minutes later. On the 22nd, satellite I. will reappear from occultation at 10h. 36m. P.M. On the 27th, satellite II. will reappear from occultation at 11h. 58m. P.M. On the 28th, the ingress of the shadow of satellite I. begins at 12h. 18m., as does that of the satellite casting it at 12h. 52m. P.M. On the 29th, satellite I. will disappear in eclipse at 9h. 40m. 12s. P.M., to reappear from occultation 21 minutes after midnight. Lastly, satellite I. will pass off Jupiter's disc at 9h. 29m. P.M. on the 30th. Saturn is visible during the whole of the amateur's ordinary night, but is best seen about 8 P.M. or so. He will be found somewhat to the west and a little to the north of ζ Geminorum ("The Stars in their Seasons," map ii.). He is, as always, a superb object in any telescope from $2\frac{3}{4}$ inches in aperture upwards. Uranus is now coming into a better position for the observer, and (notably towards the end of the month) may now be very fairly seen by midnight or even sooner. He may be picked up to the SSE. of γ Virginis, and identified by his pale-blue disc. Neptune is rapidly getting lost in the twilight. The Moon enters her first quarter at 1h. 7·8m. on the 3rd, is full at 8h. 33·9m. P.M. on the 9th, enters her last quarter at 1h. 42·1m. P.M. on the 16th, and is new at 4h. 9·7m. in the afternoon of the 24th. Nine occultations of fixed stars occur during the present month at convenient hours. The first happens on March 2, when Aldebaran will disappear at the Moon's dark limb at 5h. 47m. P.M., at an angle of 182° from her vertex, reappearing at 6h. 4m. P.M. at her bright limb at a vertical angle of 210°. On the 5th, a 6th magnitude star, *f* Geminorum, will disappear at the dark limb 41 minutes after midnight, at a vertical angle of 43°. It will emerge from behind the Moon after she has set. On the 8th, 45 Leonis, a 6th magnitude star, will disappear at the dark limb at 6h. 24m. P.M. at an angle from the Moon's vertex of 68°. It will reappear at her bright limb at 7h. 14m. P.M. at an angle of 185° from her vertex. Later on in the same night, ρ Leonis, of the 4th magnitude, will disappear at the dark limb at a vertical angle of 61° at 8h. 50m. P.M., to reappear at the bright limb at 9h. 54m. P.M. at an angle of 211° from the vertex. On the 27th, μ Ceti, also a

star of the 4th magnitude, will disappear at the Moon's dark limb at 6h. 42m. P.M. at an angle from her vertex of 108°, and will reappear at her bright limb at 7h. 35m. P.M. at an angle of 359° from her vertex. On the 29th, θ^1 Tauri, of the 4½th magnitude, will disappear at the dark limb at 9h. 17m. P.M. at a vertical angle of 117°, reappearing at the bright limb at 10h. 13m. P.M. at an angle of 335° from the Moon's vertex. At 9h. 26m. P.M., θ^2 Tauri, another 4½th magnitude star, will disappear at the dark limb at an angle of 91° from the Moon's vertex. Its reappearance at the bright limb will occur five minutes sooner than that of θ^1, which was occulted before it. It will happen at an angle of 0°, or *at* the Moon's vertex. On the 29th, B.A.C. 1391, a star of the 5th magnitude will disappear at the dark limb at 10h. 16m. P.M. at a vertical angle of 159°, its reappearance at 11h. 7m. P.M. at the bright limb of the Moon occurring at a vertical angle of 288°. Lastly, on the 30th, 115 Tauri, a 6th magnitude star, will be occulted by the Moon's dark limb at 9 minutes after midnight, at an angle of 173° from her vertex, but she will have set ere it reappears. At noon to-day the Moon is in Taurus, through which constellation she is travelling until 3h. A.M. on the 4th, when she arrives at the western edge of the narrow northern prolongation of Orion ("The Seasons Pictured," plate xxiii.). It takes her 12 hours to cross this, and at 3 o'clock in the afternoon of the same day she emerges in Gemini ("The Seasons Pictured," plate xxiv.). Her passage across Gemini occupies her until 7h. A.M. on the 6th, when she quits it for Cancer. She remains in Cancer until 5h. 30m. P.M. on the 7th, when she enters Leo. Her journey through Leo is completed by 2h. A.M. on the 10th, at which hour she crosses into Virgo ("The Seasons Pictured," plate xxv.). She quits Virgo in turn for Libra at 9h. P.M. on the 12th ("The Seasons Pictured," plate xxvi.). In the course of her passage over Libra, she arrives at 4h. P.M. on the 14th on the confines of the narrow northern strip of Scorpio; and when 9 hours later she has traversed this, it is to pass out at its eastern edge into Ophiuchus. She quits Ophiuchus and enters Sagittarius at 5h. P.M. on the 16th, and Sagittarius in turn for Capricornus at 6h. A.M. on the 19th ("The Seasons Pictured," plate xxi.). At 4h. P.M. on the 20th she passes into Aquarius. Here she remains until 3h. P.M. on the 23rd, when she enters Pisces ("The Seasons Pictured," plate xxii.). She is travelling through Pisces until 6h. 30m. P.M. on the 26th, at which hour she arrives at the northern outlier of Cetus. Before noon the next day she has passed out of this into Aries. At 2h. P.M. on the 28th she leaves Aries for Taurus ("The Seasons Pictured," plate xxiii.), and at 10h. A.M. on the 31st arrives, as at the beginning of the month, on the western boundary of the northern prolongation of Orion. She remains in this for about 12 hours and a half, and then leaves it for Gemini ("The Seasons Pictured," plate xxiv.). She is, of course, in Gemini at midnight on the 31st.

Our Whist Column.

BY "FIVE OF CLUBS."

MATHEWS ON WHIST.

(*Continued from* page 71.)

IT is better to lead from a suit headed by Ace, nine, than from one headed by Ace, ten; since in the latter case you are more likely to have a tenace if the suit is led by the adversary. [Modern whist would hardly countenance a choice in leading determined by such a consideration as this.]

Many good players, in leading from tierce major, begin with the King and Queen. [It is now the customary rule to do so.] This is often productive of mischief; as when [King is] played at other times from King and Queen only [that is, King and Queen with small ones, but without the Ace], the Ace may be kept up; and while each thinks his partner has it and has played accordingly, it unexpectedly appears from the adversary and disappoints their whole plan. [The reasoning here seems unworthy of so skilful a player as Mathews.] If a player leads King from tierce major, he follows immediately with Queen, unless he betakes himself to trumps, fearing a ruff. Now, on the other hand, if having led King from King, Queen, and another, he is in doubt whether the Ace lies with his partner or not, he may change suit. But it is only when he has led from King, Queen, without the Ace, that he would change to another plain suit. Doubt then can scarcely ever arise. Moreover, if in doubt whether partner holds the Ace or not (and it is seldom good play for either adversary to hold the Ace if he has it, though some of the over-clever often do it), it is best to go on with the suit, leading a small one, since the chances are in favour of bringing out the Ace this second round. In any case, the lead of King followed by Queen indicates unmistakably that you hold the Ace also.

From King, Queen, Knave, as from all high tierces, the highest is led, except that with two small ones or more the Knave should be led [to draw the Ace from your partner if he has it.]

From King, Queen, ten, in all suits lead the King; but if it passes do not pursue the lead, ascertain the Ace is in your partner's hand; for it may be kept up: but change your lead, and wait for the return of your partner—when you have the finesse of the ten if necessary.

This is no longer considered good Whist. It is nearly always better to go on with a small card than to change suit. All good players put the Ace on the King, led by an adversary, in nine cases at least out of ten. The chances are so great if your King is passed that either your partner holds the Ace or that you can do no harm by going on with the suit, that it is contrary to sound Whist policy to incur the almost certain mischief arising from a change of suit, on account of the minute chance that going on may do harm.

From King, Queen, four others, or fewer, lead the King always in plain suits, unless you hold the two last trumps, when you may [safely] play a small one. [It is not easy to see what you gain by so doing, whether the Ace lies with the enemy or with your partner. For with the two low trumps you are sure to get the lead as soon as you need it.] In trumps, lead the lowest [*generally*]. With King, Queen, and five others, the King should be led in all suits.

From King, Knave, ten, &c., in all suits, lead the ten. From King, Knave, and two or more small ones, lead the lowest.

[From King, Knave, and one small one, lead only if it is clearly your partner's suit, in which case lead King, and if it passes continue with Knave.]

[From Queen, Knave, ten, &c., lead the highest, in all suits.] From Queen, Knave, nine, and others, lead the Queen. [This is no longer approved, except sometimes late in the hand, when it is seen that the game can only be made or saved by the successful finesse of the nine.] From Queen, Knave, with two more, lead the lowest. From Queen, Knave, one other, lead the Queen. From Queen, ten, two others the lowest; [if with one other, do not open the suit unless sure it is your partner's, in which case lead Queen, and if it makes follow with ten.] With Queen and three small ones, lead the lowest. From Queen, with only two, lead [if at all] the Queen [but to do this you should have reason to think that it is your partner's suit.]

[From Knave, ten, nine, &c., lead Knave; from Knave, ten, and small ones, lead the lowest; but with only one small one the Knave. From Knave, three or more small ones lead the lowest; but with only two small ones besides the Knave, lead [if at all] the Knave.]

[Ten may be led from ten, nine, eight, and two or more small ones, but it is not a satisfactory opening, and seems only justified by a good chance of establishing and bringing in the suit. From ten, nine, and a small one, or ten, two small ones, lead ten.] In general, the lead of a ten indicates either a sequence to the King, King, Knave, ten, and another, or that the ten is the best of a weak suit.

Nine is never led by good players from a head sequence of three [though if there is great length in the suit, and trump strength, the lead may be justified]. In general, the lead of a nine indicates either—

1. A sequence up to the King.
2. King, Knave, ten, nine, with or without others not in sequence with the nine.
3. A weak suit, not more than three in number, the nine being the best.

If, when ten or nine is led by your partner, you hold either King or Knave in your own hand, you are certain the lead is from weakness, and that the whole strength of the suit [outside your own hand] is with the adversary, and play accordingly. [The inference is equally obvious if the lead of ten or nine is from either adversary, and you hold either King or Knave.]

To lead from only three cards, unless in sequence, is bad play, and only proper when you have reason to think it is your partner's suit, in which case play off the highest, even if the King or Queen.

[With Ace or King, or Queen or Knave, and one other, if you lead, which you will only do when you have reason to think the suit is your partner's, invariably lead the highest, except, of course, towards the close of a hand when you may have obtained such knowledge of the position of the cards that plain strategic reasons, as clearly recognised as in Double Dummy, show that the small one should be led. Such exceptions as these, however, are not considered in discussing general rules for leading.]

It is highly necessary to be correct in leads. When a good player leads an eight and then a seven, I know he leads from a weak suit; the contrary when he plays the seven first. It is the same even with a tray and a deuce. This is what bad players always err in, as they never can see the difference. [Of course these considerations do not apply in the same exact sense to modern play, though the necessity of correctness on the part of the leader and attention on

the part of partner, as well as attention to the play of the adversaries also, remains, or is even increased. The lead of an eight, now, followed by a seven, would mean that the leader had originally five cards of the suit. Unless, indeed, a player boldly rejects the penultimate lead and its "fourth best" devel pment, and stands on the ancient ways. For any good the penultimate and fourth best leads do ordinary players, these conventions are but a poor set-off for the loss of the valuable old method for distinguishing between weak leads and strong leads.]

(*To be continued.*)

Our Chess Column.

By "Mephisto."

END-GAMES FROM ACTUAL PLAY.

Black.

White.

J. GUNSBERG.

White won the game in the following manner:

19. P to Q6	19. B to Bsq.
20. B to R3	20. P to QKt4

With the idea of checking with Q to Kt3, to make room for the King.

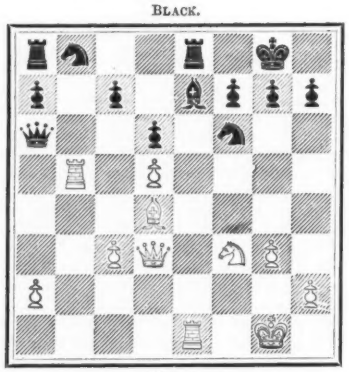
21. R to Ksq.	21. P to K5.

It would have been better to play Q to Kt3 (ch) first. Black did not see the impending disaster.

22. R × P (ch)!	22. Kt × R
23. B × P (ch)!	23. K × B
24. Q to Q5 (ch)	24. K to Ksq.
25. Q to K6 (ch)	25. B to K2
26. Q to Kt6 (ch)	26. K to Bsq.

27. P × B (ch), and wins.

Black.



White.

S. TINSLEY.

White proceeded in this elegant style:

20. R × B!

If Black retakes this Rook he loses his Queen.

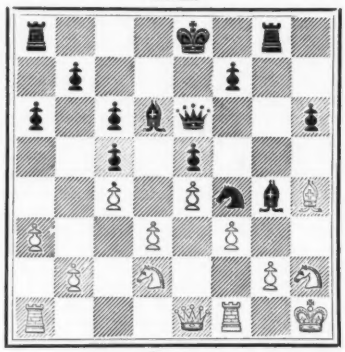
	20. P to B3
21. B × Kt!	21. Kt to Q2?

22. R to Kt8! and White won.

Awfully good.

J. GUNSBERG.

Black.



White.

A very singular ending, in which Black continued with –

	20. B to R6

Bold. Promises to become a paying investment.

21. P × B	21. Q × P
22. R to KKtsq	22. R to Kt7!
23. B to Kt3	23. Kt × P
24. Q to K3	24. Kt to B4

Every move is of great interest. Black might have won the white Queen by Kt to B7 (ch), but evidently he prefers to play for a mate.

25. QKt to Bsq	25. Castles
26. R to Qsq	26. R to Ktsq!

This whole ending forms a useful study.

27. R to Q2	27. R(Ktsq) × B
28. QR × R	28. R × R

29. P to Kt4

White has no move, as none of his pieces can play.

	29. B to K2!

Comes round at his own sweet will.

30. P × P	30. B to R5
31. P to R4	31. B to Kt6

Resigns.

PROBLEM BY MR. PROCTOR (p. 95, February).

Position.

White K on KB8. B's on K5 and QKt3. Kt's on Q5 and QR7. P's on Q3, Q6, QB2, QR5 (9 pieces).

Black K on QB4. P's on KKt5, Q2, Q5, QB6, QKt4, QR3 (7 pieces), 3 moves.

Solution.

1. B to Kt3	1. P to Kt5
2. Kt to B4	2. K × P
3. Kt to K6 mate.	

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